

FOUR NEW GENERA AND FIFTY-EIGHT NEW SPECIES OF  
STARFISHES FROM THE PHILIPPINE ISLANDS, CELEBES,  
AND THE MOLUCCAS.

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By WALTER K. FISHER,  
*Of Stanford University, California.*

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The new genera and species of starfishes described in this paper were obtained from among the Philippine Islands and the neighboring islands to the southward by the U. S. Fisheries steamer *Albatross* during her cruise of 1907-1910. These species will be fully illustrated and described in greater detail in the final report on the collection, now in course of preparation.

In a previous paper<sup>1</sup> the following genera, each based on a new species, were described:

<i>Benthogenia</i> (Porcellanasteridæ).	<i>Lithosoma</i> (Goniasteridæ).
<i>Anthosticta</i> (Astropectinidæ).	<i>Atelorias</i> (Goniasteridæ).
<i>Pontioceramus</i> (Goniasteridæ).	<i>Hymenasterides</i> (Pterasteridæ).

In the present paper the following new genera are characterized:

<i>Ctenopleura</i> (Astropectinidæ, near <i>Astropecten</i> ).
<i>Astromesites</i> (Astropectinidæ, near <i>Blakiaster</i> ).
<i>Perissogonaster</i> (Goniasteridæ, near <i>Paragonaster</i> ).
<i>Astrothauma</i> (Goniasteridæ, near <i>Calliaster</i> ).

A new subgenus of *Dytaster*, *Koremaster*, founded on a new species, *Dytaster evaulus*, is described.

A list of the new species and subspecies is given for quick reference.

PORCELLANASTERIDÆ.

<i>Sidonaster psilonotus</i> .	<i>Ctenodiscus orientalis</i> .
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GONIOPECTINIDÆ.

<i>Goniopecten asiaticus</i> .	<i>Prionaster gracilis</i> .
<i>Prionaster analogus</i> .	<i>Prionaster megaloplax</i> .

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<sup>1</sup> New genera of starfishes from the Philippine Islands, Proc. U. S. Nat. Mus., vol. 40, May 17, 1911, pp. 415-427.

## ASTROPECTINIDÆ.

<i>Astropecten acanthifer phragmorus.</i>	<i>Persephonaster luzonicus.</i>
<i>Astropecten eremicus.</i>	<i>Persephonaster tenuis.</i>
<i>Astropecten luzonicus.</i>	<i>Persephonaster multicectus.</i>
<i>Astropecten tenellus.</i>	<i>Persephonaster suluensis.</i>
<i>Astropecten pedicellaris.</i>	<i>Persephonaster ædiplax.</i>
<i>Ctenopleura astropectinides.</i>	<i>Persephonaster habrogenys.</i>
<i>Ctenophoraster diploctenus.</i>	<i>Persephonaster monostæchus.</i>
<i>Psilaster gotoi.</i>	<i>Tritonaster evorus.</i>
<i>Psilaster robustus.</i>	<i>Dipsacaster diaphorus.</i>
<i>Astromesites compactus.</i>	<i>Patagiaster sphaerioplax.</i>
<i>Persephonaster eurjactis.</i>	<i>Dytaster (Koremaster) evaulus.</i>
<i>Persephonaster anchistus.</i>	

## GONIASTERIDÆ.

<i>Mimaster notabilis.</i>	<i>Nymphaster meseres.</i>
<i>Pseudarchaster oligoporus.</i>	<i>Nymphaster habrotatus.</i>
<i>Aphroditaster microceramus.</i>	<i>Nymphaster atopus.</i>
<i>Paragonaster ctenipes hypacanthus.</i>	<i>Ceramaster smithi.</i>
<i>Paragonaster stenostichus.</i>	<i>Peltaster cycloplax.</i>
<i>Perissogonaster insignis.</i>	<i>Sphæriodiscus scotocryptus.</i>
<i>Rosaster nannus.</i>	<i>Iconaster perierctus.</i>
<i>Rosaster mimicus.</i>	<i>Astroceramus lionotus.</i>
<i>Rosaster mamillatus.</i>	<i>Astroceramus sphæriostictus.</i>
<i>Nymphaster euryplax.</i>	<i>Calliaster corynetes.</i>
<i>Nymphaster dyscritus.</i>	<i>Astrothauma euphylactem.</i>
<i>Nymphaster mucronatus.</i>	<i>Anthenooides granulatus.</i>
<i>Nymphaster leptodomus.</i>	<i>Anthenooides lithosorus.</i>
<i>Nymphaster moluccanus.</i>	<i>Anthenooides rugulosus.</i>
<i>Nymphaster arthrocnemis.</i>	

## Family PORCELLANASTERIDÆ.

## SIDONASTER PSILONOTUS, new species.

Differing from *S. vaneyi* and *S. batheri* in the almost entire absence of abactinal spinelets.  $R=22$  mm.,  $r=11$  mm.;  $R=2$  r. Breadth of ray at distal edge of cribriform organ, 7 mm.; width of cribriform organ 6.5 mm.; height, interradially, 4 mm.

Abactinal integument devoid of spinelets except for about 24, scattered close to each cribriform organ, and not extending distally beyond the edge of this organ. Spinelets about as long as those on surface of cribriform organ. Papulæ numerous, prominent, and occupying a pentagonal area, the corners of which touch the middle of each cribriform organ. Abactinal plates, spaced, microscopic, perforated, roundish, or irregular in outline. Cribriform organs very prominent, wider than high, with slightly convex upper border, and leaving only a very narrow bare area on distal edge of the plates. Superomarginals with a single, slender, prominent, sharp spinule, usually bent transversely across the smooth abactinal integument, and with a shorter companion on the second plate. Superomarginals

7 in number, and higher than inferomarginals. Terminal plate with 5 terminal, prominent, sharp spinules. Adambulacral plates with 2 marginal spinules, occupying about the adoral half of the concave furrow margin. Mouth plates with 4 tapering, sharp marginal spines spaced from the unpaired median tooth.

*Type*.—Cat. No. 30504, U.S.N.M.

*Type-locality*.—Unknown, but probably among the Philippine Islands.

CTENODISCUS ORIENTALIS, new species.

Differs from *Ctenodiscus crispatus* in having longer and relatively much more slender rays, on which the paxillar area is very narrow; constantly very small paxillæ; very much more numerous marginal plates; lower inferomarginals, of which the whole exposed surface is confined to lateral surface of ray; very delicate, and not at all flattened fasciole spinelets; smaller and more numerous actinal plates in each corresponding double series; differently shaped and more angular adambulacral plates, with a different armature; madreporic plate with finer and more numerous ridges.  $R=52$  mm.,  $r=14$  mm.,  $R=3.7$  r; breadth of ray at middle of R, about 10 mm. Marginal plates 26 or 27 in each series. In each double series of actinal intermediate plates nearest interradiial line, 16 to 23 plates (8 to 12 in a single series). In *crispatus* 16 plates is the maximum number. Adambulacral plates with the aboral half of furrow margin excavated to receive the tube foot, the adoral half being prominent and angular, with 3 tapering, sharp spinules, the median the longest, proximally equaling width of plate, distally exceeding width. One or 2 smaller spinelets continue the furrow series along the concave portion of margin, and directly behind these on the surface of plate is a conical hyaline spinelet stouter and shorter than the furrow spinelets, except on the first 5 or 6 plates where it is more delicate than the furrow spinelets. Mouth plates with 4 or 5 marginal and 5 to 8 suboral spinelets.

*Type*.—Cat. No. 30505, U.S.N.M.

*Type-locality*.—Station 5528, between Siquijor and Bohol Islands, Philippine Islands, 429 fathoms, globigerina ooze; bottom temperature,  $53.3^{\circ}$  F.

Family GONIOPECTINIDÆ.

GONIOPECTEN ASIATICUS, new species.

Differing from *G. demonstrans* in having a complete series of spines on both supero and inferomarginal plates and open cribriform organs between the proximal marginals.  $R=135$  mm.,  $r=27$  mm.,  $R=5$  r; breadth of ray at base, 31 mm. Disk moderate; rays long, robust, with vertical sides. Marginal plates massive, with fasciolar grooves containing cribriform organs, these proximally open as in Porcel-

lanasteridæ. Paxillæ large, crowded, with upward of 60 short subequal spinelets on rather high tabula. Adambulacral plates with 6 to 10 furrow spines; the adoral conspicuously enlarged on proximal plates; also with 1 or 2 prominent subambulacral spines distally, and 5 to 8 proximally.

*Type*.—Cat. No. 30506, U.S.N.M.

*Type-locality*.—Station 5121, east coast of Mindoro, Philippine Islands, 108 fathoms, dark-green mud.

### Genus PRIONASTER Verrill.

#### KEY TO KNOWN SPECIES OF PRIONASTER.

- a*<sup>1</sup>. A specialized subambulacral spine present; inferomarginal spines well developed and present on all the plates.
- b*<sup>1</sup>. Superomarginal spine conspicuous and present on all the plates; paxillæ small.
- c*<sup>1</sup>. R equaling not more than 5 r; distal superomarginals apparently in contact medially; madreporic body small with transverse striæ; cribriform organs of interbrachium only slightly open; odd interradial double series of actinal intermediate plates narrow at inner end, the series not wedge shaped; first adambulacral plate perceptibly compressed; 10 or 11 furrow spines. .... *analogus*.
- c*<sup>2</sup>. R equaling more than 6 r; distal superomarginals not in contact medially; madreporic body large with radiating striæ; cribriform organs open; odd interradial double series of actinal intermediate plates wide at inner end, the combined series wedge-shaped; first adambulacral not compressed; 12 or 13 furrow spines. .... *gracilis*.
- b*<sup>2</sup>. Superomarginal spine absent or very small and present only on a part of the plates; paxillæ very large; madreporic body large with radiating striæ; cribriform organs moderately open; paxillar area reaching terminal plate. .... *megaloplax*.
- a*<sup>2</sup>. No specialized subambulacral spines; inferomarginal spines poorly developed and only on part of the plates; paxillæ moderately large; first adambulacral plate not compressed; 10 to 12 furrow spines. .... *elegans* Verrill.

#### PRIONASTER ANALOGUS, new species.

Superficially resembling *Goniopecten asiaticus*, but with smaller paxillæ; differing from *P. elegans* Verrill in having smaller paxillæ, a complete series of marginal spines on both series, and a conspicuous subambulacral spine. R = 105 mm., r = 23 mm., R = 4.6 r; breadth of ray at base, 24 mm.; at eighth inferomarginal, 12 mm. Rays long, slender, tapering abruptly at base, then scarcely at all until near end; rays roughly rectangular in section, the 4 angles abruptly rounded; disk moderate; interbrachial arcs wide and open. Paxillæ rather small, close-set, the area being very narrow on outer two-thirds of ray, and almost obliterated for the length of the distal 10 or 11 superomarginals, which nearly touch medially. Marginal fascioles or cribriform organs not open; furrow spines 10 or 11, and beyond base of ray a subambulacral spine slightly larger than the inferomarginal spine.

*Type*.—Cat. No. 30507, U.S.N.M.

*Type-locality*.—Station 5123, east coast of Mindoro, Philippine Islands, 220 to 283 fathoms, green mud.

PRIONASTER GRACILIS, new species.

Differs from *Prionaster analogus* in having conspicuously longer rays, with a distally wider paxillar area which reaches terminal plate; paxillæ with slenderer, sharper spinelets; superomarginals narrower abactinally; cribriform organs open and exposed proximally; longer marginal spines; more numerous adambulacral spinelets; first adambulacral not compressed; double series of interradian actinal plates wider at inner or central end; enlarged subambulacral on middle portion of ray only.  $R = 165$  mm.,  $r = 24$  mm.,  $R = 6.9 r$ ; breadth of ray at base, 24 mm., at tenth inferomarginal, 14 mm. Paxillæ small and crowded. Superomarginals 74, the distals about as wide as high (much wider than high in *analogus*). Cribriform organs much more open than in *analogus* and more as in *Goniopecten asiaticus*. In interbrachium the width of the exposed portion of organ (exclusive of marginal web) is a little over one-third height of superomarginal, or one-half lateral face of inferomarginal. Adambulacral plates angular as in *analogus*, but in midregion of ray not so strongly so and with 12 to 14 furrow spines, webbed for nearly half their length, the median spinelets slightly the longest. Four or 5 shorter spinelets on outer border of plate, immersed in membrane, one of them becoming a specialized subambulacral on the midregion of ray; not enlarged on distal or proximal part of ray.

*Type*.—Cat. No. 30508, U.S.N.M.

*Type-locality*.—Station 5425, Sulu Sea (lat.  $9^{\circ} 37' 45''$  N.; long.  $121^{\circ} 11'$  E.), 495 fathoms, gray mud, coral sand; bottom temperature,  $49.4^{\circ}$  F.

PRIONASTER MEGALOPLEX, new species.

Differing from *Prionaster analogus* in the following features: Large compact paxillæ with very numerous spinelets; large madreporic body; superomarginals not in contact distally; superomarginal spines absent or rudimentary; more open cribriform organs; relatively larger inferomarginal spines; the odd interradian double series of actinal intermediate plates broader at inner end and with more plates; first adambulacral not markedly compressed; more numerous furrow spines.  $R = 250$  mm.,  $r = 50$  mm.,  $R = 5 r$ ; breadth of ray at base, 56 mm., at tenth superomarginal, 28 mm., at middle of ray, 20 mm. Paxillæ closely crowded, with stout pedicels, bearing each a flat-topped polygonal group of equal terete, blunt spinelets, about 25 to 30 occupying the periphery, and 20 to 40 the center. Superomarginals 74, the special spinule being either absent, or present as a small spinelet on the proximal half of ray. Inferomarginal spine

longer than in *analogus* and about as in *gracilis*. Cribriform organs rather open in interbrachium the width of exposed area of fasciolar spinelets equaling one-fifth or slightly less the height of superomarginal. Adambulacral plates strongly angular, the adoral facet the shorter. Furrow spines 12 or 13, terete capitate, in a palmate series and basally webbed. A pointed, specialized subambulacral spine, situated on the outer aboral corner of plate is present, accompanied sometimes by a shorter companion, while 3 or 4 other shorter spinelets occur on the margin of plate, all immersed in membrane. Madreporic body very large, in diameter equal to length of first 3 superomarginals and situated twice its diameter from margin. Striæ fine, radiating from a point midway between center and adcentral margin.

*Type*.—Cat. No. 30509, U.S.N.M.

*Type-locality*.—Station 5624, between Gillolo and Makyan Islands, Molucca Islands (lat.  $0^{\circ} 12' 15''$  N.; long.  $127^{\circ} 29' 30''$  E.), 288 fathoms, fine sand.

#### Family ASTROPECTINIDÆ.

##### ASTROPECTEN ACANTHIFER PHRAGMORUS, new subspecies.

Very similar to *A. acanthifer* Sladen, but differing in having narrower rays, more perpendicular superomarginals, bearing larger spines on the extreme upper and inner edge of plate (not spaced conspicuously therefrom); a relatively longer actinal inferomarginal spine, and longer marginal spines generally (especially in proportion to width of ray); an incipiently enlarged subambulacral (more noticeable in young examples).  $R=48$  mm.,  $r=8$  mm.,  $R=6$  r; breadth of ray at second superomarginal, 9 mm.

*Type*.—Cat. No. 30510, U.S.N.M.

*Type-locality*.—Station 5157, vicinity of Jolo, Sulu Archipelago, 20 fathoms, sand and shells.

No species of the Indo-Pacific region, other than the well-known *Astropecten polyacanthus*, has the superomarginal spines as long as those of *phragmorus*. The spines slightly exceed in length the height of the plate and stand on the extreme upper end. They are also markedly stouter than in *acanthifer*.

The following four species of *Astropecten* are from deep water and are of slender habit, resembling *Astropecten pusillulus* Fisher and *A. griegi* Kæhler. The subjoined synopsis will serve to distinguish them from one another.

#### KEY TO SPECIES.

- a*<sup>1</sup>. No superomarginal spines; paxillæ small delicate; abactinal spiniform pedicellariæ; furrow spines 4 or 5.....*eremicus*.  
*a*<sup>2</sup>. Superomarginal spines present, small.  
*b*<sup>1</sup>. Superomarginal spines at base of ray only; subambulacral spines 3 or 4, none enlarged; mouth spines in regular series.....*luzonicus*.

- b<sup>2</sup>. Superomarginal spines on all except outer third of ray; subambulacral spines more than 5, one in the first series enlarged; mouth spines irregularly arranged.
- c<sup>1</sup>. No superomarginal or inferomarginal pedicellariæ; abactinal and adambulacral pedicellariæ very few; paxillæ medium-sized; superomarginals of proximal half of ray not longer than wide; lateral spines 3, sometimes 4. . . . . *tenellus*.
- c<sup>2</sup>. Numerous abactinal, superomarginal, inferomarginal, and adambulacral pedicellariæ; superomarginals (except the first 8 or 9 plates) longer than wide; lateral spines 4, on distal third of ray, 3. . . . . *pedicellaris*.

ASTROPECTEN EREMICUS, new species.

Disk small, rays flexible, and fairly long and slender; relation of R to r variable; in type R=51 mm., r=9 mm., R=5.66 r; breadth of ray at base, 11 mm. Paxillæ small, not crowded, and with 5 to 8 delicate, blunt, membrane-invested spinelets borne on relatively high slender pedicels, the whole about 1 mm. high. Scattered over paxillar area, numerous pedicellariæ borne on special plates and with usually 4 spiniform jaws nearly as thick as the pedicel of a paxilla. Superomarginals (36 to 38) dorsal in position, the upper ends of inferomarginals forming margin of ray, and without special spines but covered with delicate spinelets invested in pulpy membrane. Inferomarginals about as wide as length of two; lateral spines 2, the upper the longer,\* and equaling about 2½ plates in length, and in addition, on the proximal half of ray, a shorter actinal spine near the adambulacral plates; adambulacral plates with 4 or 5 slender furrow spines, and 5 or 6 similar subambulacral spines in 2 longitudinal series; sometimes a subambulacral pedicellaria with 4 to 6 spiniform jaws is present. Mouth plates narrow with 4 enlarged teeth at inner angle of combined plates, and 3 or 4 spines of about the same size at the outer angle of each plate; between the 2 groups numerous smaller spinelets, decreasing in size from the median suture toward margin. Actinal intermediate pedicellariæ with 5 or 6 spiniform jaws.

*Type*.—Cat. No. 30511, U.S.N.M.

*Type-locality*.—Station 5491, Surigao Sea, between Leyte and Mindanao, 736 fathoms, green mud and coral; bottom temperature, 52.3° F.

The absence of superomarginal spines and the presence of abactinal, actinal intermediate, and subambulacral pedicellariæ will suffice to distinguish *eremicus* from *A. griegi* Kœhler. *A. eremicus* resembles *A. pusillulus* of the Hawaiian Islands, but the latter has 3 furrow spines, the much flattened median spine being stouter and wider than in *eremicus*; shorter paxillar pedicels and shorter spinelets; no actinal inferomarginal spinule in addition to the 2 lateral spines (except sometimes on the first 2 or 3 plates); shorter rays and relatively larger disk; no abactinal pedicellariæ.

## ASTROPECTEN LUZONICUS, new species.

Similar to *A. eremicus*, but with longer, narrower rays, a small tubercular spine on the first few superomarginal plates; only 3 furrow spines beyond the first 5 or 6 plates; armature of each mouth plate in 2 regular longitudinal series. Disk very small, rays long, slender, and very flexible; paxillar area narrow; paxillæ small, delicate; lateral spines 2 or 3; furrow spines 3; subambulacral spines 2 to 4, none enlarged.  $R = 68$  mm.,  $r = 9$  mm.,  $R = 7.55 r$ ; breadth of ray at base, 9 to 10 mm.

*Type*.—Cat. No. 30512, U.S.N.M.

*Type-locality*.—Station 5112, Balayan Bay, southern Luzon, 117 fathoms, dark green mud; bottom temperature,  $52.4^{\circ}$  F.

In this species the paxillæ are small and slender as in *eremicus* with 5 to 8 slender, blunt, membrane-invested spinelets, as long as or slightly longer than the pedicel. Abactinal pedicellariæ very few and inconspicuous. Superomarginal plates, about 55 in number, are similar to those of *eremicus* in form and position, but the central spinelets are not sharp and squamiform as in *eremicus*; rather they are blunt and clavate or cylindrical, and the first 5 to 10 plates bear at the upper end of the plate; slightly spaced from the inner edge, a small upright conical sharp spine, which rapidly decreases in size and merges into the spinelets. Inferomarginal spines similar to those of *eremicus*, but the small actinal spine is lacking except rarely on the first 2 or 3 plates. No subambulacral pedicellariæ; each actinal interradial area with 5 or 6 pedicellariæ having 4 to 6 spiniform jaws. The mouth plates are similar to those of *eremicus*, but the spines are in 2 definite, regular, longitudinal series on each plate.

## ASTROPECTEN TENELLUS, new species.

Very similar to *Astropecten griegi* Kœhler, from which it differs in having a few abactinal pedicellariæ among the paxillæ, in lacking a special spine on the distal superomarginals, in having very sharp, flattened, inferomarginal spinelets, and proximally several spinules along the aboral edge of the inferomarginal plates, ventral to the lateral spines; in having the median furrow spine conspicuously flattened, not cylindrical, in having, proximally, adambulacral pedicellariæ. Disk small, rays long and slender.  $R = 108$  mm.,  $r = 10$  mm.,  $R = 10.8 r$ ; breadth of ray at base, 11 mm.

*Type*.—Cat. No. 30513, U.S.N.M.

*Type-locality*.—Station 5453, Albay Gulf, east coast of southern Luzon, 146 to 200 fathoms.

The paxillæ are slender, with commonly a central spinelet surrounded by 8 to 12 similar, delicate, terete, blunt spinelets, slightly shorter than the pedicel. The superomarginals bear a tapering, sharp, slightly flattened spine, about as long as the plate, on the



upper end and aboral margin; this is lacking on the terminal fourth or fifth of ray. Inferomarginals with 3 or 4 conspicuous slender, flattened, sharp lateral spines, and continuing this to the inner end of plate are, on the proximal plates, 3 to 5 shorter, slenderer spinules. The furrow spines are 3, rather long, the median slightly the longest, flattened, saber-shaped, and pointed, the other 2 more cylindrical, slenderer, tapering, and pointed. Subambulacral spines: Back of the furrow series a slightly oblique longitudinal series of 3, the aboral the largest, and usually longer than the median furrow spine; the others are decreasingly shorter; back of these, 3 to 5 shorter, slenderer spinelets. Actinal intermediate plates few, with a tuft of spinelets or a conical spiniform pedicellaria.

ASTROPECTEN PEDICELLARIS, new species.

Similar in general appearance to *A. tenellus*, but differing in having abundant abactinal and adambulacral pedicellariæ, as well as pedicellariæ on supero- and inferomarginal plates, smaller paxillæ, narrower superomarginal plates, and more prominent lateral spines, which are 4 in number except on outer third of ray, where 3 are present. Rays long and slender; paxillar area narrow.  $R=74$  mm.,  $r=9$  mm.,  $R=8.2$  r; breadth of ray at base, 9 to 10 mm.

*Type*.—Cat. No. 30514, U.S.N.M.

*Type-locality*.—Station 5424, Sulu Sea, off Cagayan Island, Cagayanes Islands, 340 fathoms, coral sand; bottom temperature,  $50.4^{\circ}$  F.

The paxillæ are similar to those of *A. eremicus*, with a central, terete, blunt spinelet, usually as long as or a trifle longer than the pedicel, and 8 or 9 similar ones in a peripheral series. Scattered over the paxillar area are numerous conical pedicellariæ with 3 to 6, tapering, spiniform jaws which are slightly longer than the pedicels of paxillæ. Superomarginals of proximal three-fourths of ray with a conical sharp spine about as long as the plate, and most of the plates bear near the center a low dome-shaped fasciculate pedicellaria composed of 4 to 8 slightly modified stubby spinelets. Lateral spines 4, or 3 on outer third of ray; and on inner third, 1 or 2 shorter, slenderer, but well-developed spinules on the actinal surface. The uppermost, or the second, is the longest and proximally equals  $2\frac{1}{2}$  plates. Most of the proximal plates bear a small fasciculate pedicellaria at the upper end, near the base of the first spine; and on the ventral surface of nearly all the plates are 1 to 3 similar but larger pedicellariæ. Furrow spines 3, the median compressed and thin. Inner row of subambulacral spines, 2 or 3, the aboral member enlarged, tapering, slender, flattened, blunt-pointed, and a little longer than the median furrow spine; behind these are 3 to 5 shorter spines. Instead of this arrangement many plates have the subambulacrals nearly equal and grouped to form a pedicellaria with 4 to 6 jaws.

## CTENOPLEURA, new genus.

Allied to *Astropecten*, but differing in having the gonads in a crowded series parallel to the marginal plates, and extending about a third the length of ray; inferomarginal plates with a lateral, oblique, compact comb of 3 to 5, usually 4, slender appressed spines, closely resembling the lateral comb of *Persephonaster*, and in addition 1 to 5 flattened, appressed spines on the actinal surface; adambulacral plates with usually 4 or 5 furrow spines (or, on the second and third plates, sometimes 6 or 7) instead of 3, the usual number in *Astropecten*; subambulacral spines small, none enlarged; often a fasciculate subambulacral pedicellaria is present; Polian vesicles 5. Other characters as in *Astropecten*.

*Type of the genus.*—*Ctenopleura astropectinides*, new species.

This genus includes also *Astropecten ludwigi* de Loriol, of Japan, in which the gonads are arranged in series extending about a third the length of the ray. In *Astropecten* the gonads form a single tuft on either side of the interbrachial septum. The arrangement of the gonads in series will separate *Ctenopleura* from *Leptychaster*, *Bathyiaster*, *Psilaster*, *Blakiaaster*, *Astromesites*, *Ctenophoraster*, *Persephonaster*, *Tritonaster*, and *Patagiaaster*, while the very restricted development of the actinal intermediate plates will distinguish it from other *Astropectinidæ* having serially arranged gonads, such as *Anthostictæ*, *Tethyaster*, *Thrissacanthias*, *Dipsacaster*, and *Plutonaster*. The armature of the marginals will separate *Ctenopleura* from *Lonchotaster* and *Ripaster* in which the gonads are not described.

## CTENOPLEURA ASTROPECTINIDES, new species.

Related to *C. ludwigi* (de Loriol)<sup>1</sup> but differing in having longer, narrower rays, shorter, stouter superomarginal spines confined to marginal angle of ray, strongly 4-lobed abactinal plates on papular areas, and fewer actinal inferomarginal spines.  $R = 129$  mm.,  $r = 25$  mm.,  $R = 5r$ ; breadth of ray at base, 28 mm. Disk small, rays long, narrow, very gradually tapering to a bluntly pointed extremity; abactinal integument thin, paxillæ tall, spaced, bearing a compact upright group of 10 to 15 subequal, terete, slender, blunt spinelets varying from slightly shorter to slightly longer than the cylindrical, barrel-shaped, or compressed pedicels; superomarginals encroaching conspicuously upon abactinal area, the dorsal face tumid and about twice as wide as the lateral; marginal area of plates covered with short, slender, crowded spinelets, becoming coarse roundish granules on the summit of median transverse tumidity, the angle between lateral and dorsal facets bearing a transverse series of 2 to 4 short

<sup>1</sup>*Astropecten ludwigi* de Loriol, Mém. soc. phys. et d'hist. nat. Genève, vol. 33, pt. 2, No. 1, 1899, p. 21, pl. 2, fig. 4. (Togo, Japan.)

conical spinules; the first and 3 or 4 last plates without spinules; inferomarginals proximally as wide as length of 3, slightly arched, but actinal surface not at all strongly beveled; outer end armed with oblique comb of 4 slender, sometimes slightly curved, closely placed, appressed spines, the lowest or next to lowest the longest and about  $1\frac{1}{2}$  to  $1\frac{3}{4}$  plates in length; spaced from these are proximally 2 spaced, flattened, sharp spines nearly as long as longest lateral spine; general surface covered with squamiform spinelets often spatulate in form; adambulacral plates with 4 (proximally 5 or 6 and distally sometimes 3) rather long, flattened spines, the laterals subtruncate or round-tipped; subambulacral spinelets proximally 12 to 16, subequal, slender, often flattened and only about half as long as median furrow spine; most of the plates with a conspicuous fasciculate pedicellaria, made up of 6 or 8 of the subambulacral spines; on each ray 7 or 8 actinal intermediate plates in a single row, armed with slender papilliform spinelets and sometimes a central lanceolate appressed spine; an occasional proximal plate with a fasciculate spiniform pedicellaria.

*Type*.—Cat. No. 30515, U.S.N.M.

*Type-locality*.—Station 5520, 4.5 miles southwest of Point Tagolo Light, north coast of Mindanao, 102 fathoms; bottom temperature, 61.3° F.

CTENOPHORASTER DIPLOCTENIUS, new species.

Very closely resembling *C. hawaiiensis* in general appearance, but differing in having no median radial area of smaller irregularly arranged paxillæ; in having the paxillæ in regular curved transverse series on rays, with fewer paxillæ to the series than in *hawaiiensis*; in having finer superomarginal spinelets and more numerous, minute, superomarginal fasciculate pedicellaria; in having slenderer and fewer inferomarginal spines, arranged in 2 oblique arcuate lateral series, and 1 transverse actinal series (not 3 and 2, respectively, as in *hawaiiensis*); in having tiny inferomarginal and numerous prominent actinal intermediate and subambulacral fasciculate pedicellaria; in having fewer subambulacral spines, and prominent central spines to the actinal interradiial plates.  $R = 105$  mm.,  $r = 15$  mm.,  $R = 7r$ ; breadth of ray at base, 18 or 19 mm.

*Type*.—Cat. No. 30516, U.S.N.M.

*Type-locality*.—Station 5272, China Sea, vicinity of southern Luzon (lat. 14° N.; long. 120° 22' 30" E.), 118 fathoms, mud, shells, coral sand; 1 specimen; bottom temperature, 57.4° F.

PSILASTER GOTOI, new species.

$R = 58$  mm.,  $r = 14$  mm.,  $R = 4.1 r$ ; breadth of ray at middle of interbrachium, 16 mm.; at third superomarginal, 13.5 mm. Disk fairly large, rays evenly tapered to a pointed extremity; interbrachia

about  $90^\circ$ , rounded; superomarginals with a single row of prominent appressed spines, extending nearly to tip of ray; inferomarginals with 2 series, one near the upper end of the plates and the other near the lower; adambulacral plates with 7 or 8 furrow spines proximally, and about 10 subambulacral spines in 2 series; mouth plates with a horizontal fan of 4 prominent teeth. Differs from *Ps. agassizi* (Køehler) in having only 1 superomarginal series of spines, no well-defined central naked area on inferomarginals, and in having the superomarginals less conspicuous, dorsally, and the inferomarginals practically confined to the sloping side wall of ray; furrow spines slightly more numerous.

*Type*.—Cat. No. 30517, U.S.N.M.

*Type-locality*.—Station 5468, Lagonoy Gulf, southeastern Luzon, 569 fathoms, green mud.

This, as well as the following form, come within the restricted group *Phidiaster* of Køehler.

The species is named in honor of Dr. Seitaro Goto, of the Imperial University, Tokyo.

**PSILASTER ROBUSTUS, new species.**

$R=30$  mm.,  $r=9.5$  mm.,  $R=3.15$  r; breadth of ray at base, 12 mm.; height of combined marginal plates at middle of interbrachium, 6 mm.; disk large, rays stout and short, evenly tapered; superomarginal plates very massive, encroaching conspicuously upon paxillar area, than which they are wider at middle of ray; paxillæ small, spaced; one series of superomarginal spines; one series of lateral inferomarginal spines and an incomplete second (ventral) series at base of ray; marginal plates covered with squamules and without naked areas; furrow spines 6 or 7. Differing from *Ps. gotoi* in having much more massive superomarginals, which encroach more upon paxillar area, smaller paxillæ, thicker terminal plate, only 1 complete series of inferomarginal spines, shorter and more globose suboral spines, slightly shorter adambulacral spines, and a thicker, more robust, form.

*Type*.—Cat. No. 30518, U.S.N.M.

*Type-locality*.—Station 5632, south of Batjan Island, Molucca Islands (lat.  $1^\circ$  S.; long.  $127^\circ 50'$  E.), 845 fathoms.

The paxillar area is sunken below the level of the broad tumid superomarginal border, the paxillæ being small, with about 12 coordinated, close-set spinelets on the largest plates of interradial portions of disk. The superomarginal spine is near the inner edge of the first 2 plates, but on the third is about twice as far from the inner edge, and on the fourth stands on the rounded border between the dorsal and lateral faces of the plate. Beginning with the second or third inferomarginal plates is a row of sharp, prominent, flattened spines, slightly larger than the superomarginal, extending nearly to

tip of ray. The first 3 to 6 plates bear a similar smaller spine, spaced from the lower end of the plate one-fifth to one-third width of plate. Surface of plate is covered with spaced squamules. Furrow spines 6 or 7, compressed, blunt, the median with edge to furrow; subambulacral spines 8 or 10, much shorter, clavate, thick, pulpy, and papilliform, in 2 series.

The absence of a second series of superomarginal spines and of naked areas on the marginal plates will separate *robustus* from *agassizi*. The inferomarginals of *agassizi* have a well-developed ventral face, while in *robustus* they form a steeply sloping side to the ray when viewed from below, there being no separate ventral and lateral faces.

#### ASTROMESITES, new genus.

Resembling *Persephonaster* and *Psilaster* in form, but differing from them and resembling *Leptychaster* and *Blakiaster* in the armature of the adambulacral and mouth plates, and especially in the possession of an odd interradial series of actinal intermediate plates. Differing from *Blakiaster* in having abactinal plates compact, independent, true paxillæ and in having well-developed marginal fascioles. Marginal plates massive, the inferomarginals with an appressed comb of slender spines; superomarginals unarmed; paxillæ large, flat-topped, crowded; actinal intermediate plates extending in a single series far along ray; adambulacral plates with an angular furrow margin bearing a divergent group of 5 to 7 spines and numerous subambulacrals, as in *Leptychaster*; mouth plates with extensive, convex surface; 3 series of crowded suborals, graded in length from the straight, even furrow series of long spines, which are graduated toward 2 inner teeth; no sharp-angular furrow series as in *Persephonaster*; disk small, rays stout, rather slender; actinal interradial areas small, the intermediate plates extending two-thirds the length of ray.

*Type of the genus.*—*Astromesites compactus*, new species.

#### ASTROMESITES COMPACTUS, new species.

R = 78 mm., r = 17 mm., R = 4.6 r; breadth of ray at base, 20 mm. Disk small, rays narrow but stout, tapering regularly to a pointed but not attenuate extremity; sides of ray fairly high, rounded; marginal plates massive; interbrachial angle abruptly rounded; paxillæ large, crowded, with numerous, short, crowded, blunt spinelets; superomarginals unarmed; inferomarginals with lateral comb of 4 to 6 appressed spines; marginal fascioles rather deep, abrupt, and narrow, furrow series angular, of 5 to 7 spines; mouth plates with straight, numerous, furrow series, and 3 series of suborals; interradial areas small, an odd interradial series of intermediate plates, and a single series far along ray; no pedicellariæ.

*Type.*—Cat. No. 30519, U.S.N.M.

*Type-locality*.—Station 5289, Verde Island Passage, north of Mindoro (lat.  $13^{\circ} 41' 50''$  N.; long.  $120^{\circ} 58' 30''$  E.), 172 fathoms, broken shells, sand.

*Astromesites* differs from *Persephonaster*, *Psilaster*, and *Bathybiaster* in having an odd interradial series of actinal intermediate plates. It differs further from *Persephonaster* in lacking the latter's characteristic angular marginal series (or fasciculate group) of oral spines, and in having an angular series of furrow spines, rather than a comb; from *Psilaster* in having broader mouth plates with numerous, crowded suboral spines in more than 1 series, an angular (not pectinate) furrow armature, and in lacking the thick, fleshy, actinal spinelets; from *Bathybiaster* in lacking lobes on the abactinal plates, fleshy actinal spinelets, and in having a different type of dental and marginal armature. *Astromesites* agrees with *Blakiaster* and *Leptychaster* in having the odd interradial series of actinal intermediate plates, and the same type of adambulacral armature. It differs from *Blakiaster*, however, as indicated in the diagnosis, and from *Leptychaster* in having armed inferomarginals of the type of *Psilaster* and *Persephonaster*. I should be inclined to rank *Astromesites* with *Blakiaster* were not the abactinal plates wholly different.

#### Genus PERSEPHONASTER Alcock.

##### KEY TO THE SPECIES OF PERSEPHONASTER HEREIN DESCRIBED.

- a*<sup>1</sup>. Marginal plates broad and conspicuous, the inferomarginals forming a wide bevel to actinal surface and bearing, on the outer tumid end, which projects laterally beyond superomarginals, a prominent comb of slender spines, covering, at least proximally, a second smaller parallel comb; superomarginals with a transverse series of appressed spines or spinules.
- b*<sup>1</sup>. With several spines on the actinal surface of inferomarginals in addition to the lateral comb.
- c*<sup>1</sup>. Rays broad and petaloid, abruptly narrowed to a very attenuate extremity; paxillar area broad; actinal intermediate plates extending fully two-thirds the length of ray, and larger; inferomarginal plates wider; superomarginal spines more prominent and numerous.....*curyactis*.
- c*<sup>2</sup>. Rays narrower, evenly tapered; paxillar area narrower; actinal intermediate plates extending a little over one-half length of ray, and very small distally; inferomarginals narrower; superomarginal spinules inconspicuous.  
.....*luzonicus*.
- b*<sup>2</sup>. Only the lateral comb of inferomarginal spines (except on first 3 or 4 plates).  
.....*anchistus*.
- a*<sup>2</sup>. Marginal plates massive, but not especially broad, the side of ray vertical; rays slender, more or less attenuate at tip; second lateral comb obsolete; superomarginals unarmed or with single spine, not a transverse series.
- b*<sup>1</sup>. Superomarginals not conspicuously tumid and without special spine; no abactinal pedicellariæ independent of paxillæ.....*tenuis*.
- b*<sup>2</sup>. Superomarginals tumid, with a single spine, forming a straight series along ray; among the paxillæ low plates bearing fasciculate pedicellariæ independent of paxillæ; no erect lateral spine above the inferomarginal comb.

- c<sup>1</sup>. Superomarginals very tumid with the transverse ridge situated at middle of plate, and evenly rounded from inner to outer edge; furrow spines 9; marginal fan of oral spines, 3 or 4, not prominent.....*multicinctus*.
- c<sup>2</sup>. Superomarginals less tumid and with the transverse ridge situated between center and distal margin of plate; an appreciable angle between the dorsal and lateral surfaces; inferomarginals broader, with less crowded, slenderer squamules; furrow spines 7 or 8; marginal fan of mouth spines 5 to 7, prominent.....*suluensis*.
- b<sup>3</sup>. Marginals tumid, the inferomarginals being narrow and provided usually with an erect conical spine at upper end of plate, above the appressed, longer spines of the lateral comb; superomarginal spines in a single series along ray, passing from the inner edge of plate toward outer, after the fifth plate.  
.....*monostæchus*.
- a<sup>3</sup>. Marginal plates not massive, the superomarginals being small, squarish, and tumid, with a spine near center, and sometimes on the outer part of ray more than 1; the inferomarginals narrow but with a well-marked actinal face; rays depressed; paxillæ rather spaced and delicate.
- b<sup>1</sup>. Rays broader; inferomarginals at base of ray about two-thirds to three-fourths as long as wide; no actinal series of spinules; more than 1 series of suboral spines, the mouth plates as a whole larger; marginal and subambulacral fasciculate pedicellariæ; furrow spines 6 or 7.....*ædiplax*.
- b<sup>2</sup>. Rays slenderer; inferomarginals narrower, the width not exceeding length, except on first 2 plates; 2 or 3 actinal inferomarginal spinules proximally, in addition to lateral comb; only 1 series of suboral spines; no marginal or adambulacral pedicellariæ; furrow spines 5 or 6.....*habrogenys*.

PERSEPHONASTER EURYACTIS, new species.

R = 92 mm., r = 23 mm., R = 4 r; breadth of ray at base, 24 to 26 mm. Rays depressed, broadly lanceolate, abruptly constricted near tip into a very attenuate, sharp extremity; interbrachium abruptly rounded-angular; superomarginal plates broader than long, and after the first half dozen, confined to abactinal surface; each tumid plate with a transverse, appressed comb of 3 to 7, flat, sharp spines; inferomarginals much broader than long, the outer tumid end bearing a comb of about 5 prominent, sharp spines; proximal plates with a second lateral comb of 3 to 5 spines covered by the first; curved furrow comb of 6 or 7 rather long spines; subambulacral proximally about 6 in a single irregular series; actinal intermediate plates extending two-thirds length of ray.

*Type*.—Cat. No. 30520, U.S.N.M.

*Type-locality*.—Station 5297, Verde Island Passage, off Batangas Bay, Luzon (lat. 13° 41' 20" N.; long. 120° 58' E.), 198 fathoms, mud and sand.

The paxillæ are medium sized, low, arranged in slightly oblique transverse series on rays, at the base of which 6 or 7 transverse series correspond to 2 superomarginals. The spinelets usually stand erect in a compact flat-topped roundish group, causing the paxillæ to be spaced about one-half their diameter apart. Fifteen to 20 peripheral and 10 to 15 central, slender, terete, blunt spinelets, longer than the stout pedicel, compose the crown of the larger paxillæ. Many of the

paxillæ bear a central fasciculate or pectinate pedicellaria consisting of 4 to 8 jaws considerably stouter, but not much longer, than the regular spinelets. The median or outer admedian superomarginal spine is usually the longest, about equaling the length of plate. The lowest or next to lowest inferomarginal spine of the lateral comb is the longest, or the 3 lowermost subequal, and equal to the length of  $2\frac{1}{2}$  inferomarginal plates. Continuing this series along the distal margin toward the inner end of the plate are proximally 4 or 5 and distally 2 or 3 sharp, appressed, flattened, much shorter spines. The surface of the plate is covered with medium-sized, ovate, or obovate, imbricating, appressed squamules, with broad, rounded ends. They are specialized into a series of short, pointed spinules just adorally to the series of lateral spines. Adambulacral plates separated by wide sutures; furrow margin bearing a curved comb of 6 or 7 long, slender, compressed round-or squarish-tipped spines, the central 2 or 3 slightly the longest and with edge to furrow, the laterals with flat side thereto.

In the shape of the ray this species is like *P. calochiles*, but lacks the stout, erect, superomarginal spine, and has the abactinal plates irregular along the radial line. The inferomarginal plates of *euryactis* are wider, and in *calochiles* the second series of actinal intermediate plates extends far along the ray. The accessory actinal inferomarginal spines are lacking in *calochiles*.

PERSEPHONASTER ANCHISTUS, new species.

Similar to *P. euryactis*, but with slightly slenderer rays which taper evenly on the outer part to an attenuate extremity; actinal inferomarginal spines lacking except on the first few plates; superomarginal spines lacking on first 3 to 5 plates, and distally 1 to 3 in number; lateral comb of spines as in *euryactis*, but the second comb very poorly developed, usually represented by a single spine, behind one of the upper spines of the first comb; paxillæ arranged as in *euryactis* and of about the same size, but with slightly longer spinelets; abactinal pedicellariæ numerous, with jaws only slightly, sometimes not any, thicker than the surrounding spinelets; subambulacral spines slightly more numerous than in *euryactis*, in 2 or 3 longitudinal series.  $R = 143$  mm.,  $r = 34$  mm.,  $R = 4.2 r$ ; breadth of ray at mid-interbrachium, 34 mm.

*Type*.—Cat. No. 30521, U.S.N.M.

*Type-locality*.—Station 5301, China Sea, vicinity of Hongkong (lat.  $20^{\circ} 37' N.$ ; long.  $115^{\circ} 43' E.$ ), 208 fathoms, gray mud, sand; bottom temperature,  $50.5^{\circ} F.$

PERSEPHONASTER LUZONICUS, new species.

Resembling in armature a short-spined variety of *P. euryactis*, but with narrower, evenly tapered rays, much narrower paxillar area, fairly large compact paxillæ having slightly shorter spinelets, narrower



inferomarginal plates, and a shorter series of actinal intermediate plates.  $R=78$  mm.,  $r=18$  mm.,  $R=4.3$  r; breadth of ray at interbrachium, about 20 mm.

*Type*.—Cat. No. 30522, U.S.N.M.

*Type-locality*.—Station 5326, off northern Luzon (lat.  $18^{\circ}32'35''$  N.; long.  $122^{\circ}01'$  E.), 230 fathoms, mud; bottom temperature,  $55.4^{\circ}$  F.

The most striking difference between this species and a less spinous variety than the typical *P. euryactis* is in the narrower rays, which instead of being rather broad near the tip and then quickly narrowing to an attenuate extremity, taper gradually from a narrower base. The superomarginals are of the same width in the two species and as a consequence the paxillar area is much narrower in *luzonicus*, its width at one-third  $R$  from center being one and two-thirds to slightly less than twice the extreme width of a neighboring superomarginal, and at two-thirds  $R$ , about as wide as the superomarginals. In *euryactis* these proportions are respectively  $2\frac{1}{2}$  to  $2\frac{3}{4}$ , and  $1\frac{3}{4}$ . Adambulacral armature similar to that of *P. euryactis*, but furrow spines 7 or 8, the eighth being usually a shorter spine at the adoral end of the series. Proximally, 8 or 9 subambulacral spines, slender, terete, blunt, much shorter than the furrow spines, and in 2 longitudinal series; distally, 10 or 12 spinules similar but relatively a little shorter in 2 series, with often the beginning of a third, on the outer part of the plate. The actinal intermediate plates, owing to the narrowness of the ray, are very small beyond the proximal third or fourth of the ray.

PERSEPHONASTER TENUIS, new species.

A slender-rayed species with block-like conspicuous marginals, which are not markedly tumid as in the "cingulate" species such as *multicinctus*, *cingulatus*, and *roulei*; superomarginals with slightly wider dorsal than lateral face; lateral face of ray perpendicular, the upper and lower margin evenly and abruptly rounded; superomarginal plates without conspicuous spines; inferomarginals narrow, with lateral comb of, proximally, 5 rather short slender appressed spines, and 1 actinal spinule on the proximal plates only; furrow spines 7 or 8; subambulacrals 4 to 7 proximally, distally 8 to 10; a few fasciculate adambulacral pedicellariæ.  $R=81$  mm.,  $r=18$  mm.,  $R=4.5$  r; breadth of ray at base, 20 mm.; at tenth superomarginal, about 11 mm.

*Type*.—Cat. No. 30523, U.S.N.M.

*Type-locality*.—Station 5301, China Sea, vicinity of Hongkong (lat.  $20^{\circ}37'$  N.; long.  $115^{\circ}43'$  E.), 208 fathoms, gray mud, sand.

This species differs from *luzonicus* in having still narrower rays; superomarginals which encroach less upon the paxillar area, and have proportionately higher lateral faces; more delicate superomarginal spinelets; practically no specialized spines, except a very small one

on the distal plates; actinally narrower inferomarginal plates with only 1 small actinal spine on a few proximal plates; shorter lateral spines; more restricted actinal intermediate plates; adambulacral pedicellariæ; proximally fewer subambulacral spines; longer and slenderer terminal plate.

PERSEPHONASTER MULTICINCTUS, new species.

Of the type of *P. cingulatus* Fisher and related to *P. roulei* Kœhler, from which it differs in having abactinal and marginal pedicellariæ; fewer paxillar spinelets; a slender appressed, central superomarginal spine, forming a single longitudinal series along ray (not 2 conical robust ones, forming 2 parallel series along ray); more numerous furrow spines. Disk larger than in either *cingulatus* or *roulei*.  $R = 110 + \text{mm.}$  (tip of ray broken),  $r = 24 \text{ mm.}$ ,  $R = 4.6 + r$ ; breadth of ray at base 28 mm. Interbrachia open; rays tapering very gradually; height of ray at base less in proportion to width than in *cingulatus* or *patagiatus*. Paxillæ small, with a low pedicel surmounted by a flat-topped group of upward of 12 peripheral and 5 to 7 central terete, blunt, spinelets as long as or slightly longer than height of tabulum; scattered abactinal fasciculate or fasciculate-pectinate pedicellariæ with 2 to 10 spiniform jaws markedly stouter than paxillar spinelets. Superomarginals over 40, shaped as in *P. cingulatus*, the median transverse line being covered with scale-like granules, the slopes on either side with tiny terete spinelets. Except for 6 or 7 interbrachial plates each plate bears near the middle 1 or 2 slender appressed, sharp flattened spinules (but forming a single series along ray); several inconspicuous fasciculate pedicellariæ present on each plate. Inferomarginals with a lateral oblique comb of 3 or 4 slender, flat, sharp appressed spines. Actual interradial areas small, each triangle with about 10 or 12 slender, elongate spines and a very few fasciculate pedicellariæ. Adambulacral plates with a curved furrow margin, 9 furrow and 2 longitudinal series of subequal slender, membrane-covered, rather fleshy, subambulacral spines, about 5 in the inner series and 4 to 7 slightly shorter ones in the second.

*Type*.—Cat. No. 30524, U.S.N.M.

*Type-locality*.—Station 5648, Buton Strait, Celebes (lat.  $5^{\circ} 35' \text{ S.}$ ; long.  $122^{\circ} 20' \text{ E.}$ ), 559 fathoms, green mud; bottom temperature,  $39.2^{\circ} \text{ F.}$

PERSEPHONASTER SULUENSIS, new species.

Near *P. multicinctus*, but differs in having the superomarginal plates with the transverse ridge between the center and aboral margin of the plate, not in the center; inferomarginals appreciably broader, with less crowded squamules; furrow spines, 7 or 8; marginal fan of mouth spines prominent, 5 to 7, nearly as long as first adambu-

lateral furrow spines.  $R=61$  mm.,  $r=14$  mm.,  $R=4.3$  r; breadth of ray at base, about 16 mm.

*Type*.—Cat. No. 30525, U.S.N.M.

*Type-locality*.—Station 5424, Sulu Sea, near Cagayanes Islands, 340 fathoms, coral sand; bottom temperature,  $50.4^{\circ}$  F.

This species is similar, also, to *P. tenuis*, but differs in the presence of the conspicuous though small superomarginal spine, the wider inferomarginals, the much less compressed first adambulacral plates, the longer and more numerous marginal mouth spines, the proximal subambulacrals in 2 series, and the specialized abactinal pedicellariæ.

PERSEPHONASTER CEDIPLAX, new species.

Marginal plates small and tumid, the superomarginals bearing a central small spine, or distally 2; the inferomarginals extending laterally slightly beyond superomarginals, the tumid outer end bearing a narrow comb of 3 or 2 slender appressed spines; no actinal inferomarginal spines; superomarginal, inferomarginal, abactinal, actinal intermediate, and subambulacral fasciculate pedicellariæ; furrow spines 6 or 7, rather long, slender, compressed; subambulacral spines 8 to 12, slender and short. Rays long, of medium width, thin, and with attenuate extremity.  $R=95$  mm.,  $r=20$  mm.,  $R=4.75$  r; breadth of ray at base, 22 mm.; breadth at two-thirds of  $r$ , 8 mm.

*Type*.—Cat. No. 30526, U.S.N.M.

*Type-locality*.—Station 5123, east coast of Mindoro, 220 to 283 fathoms, green mud.

The superomarginals, 40 in number, are quite small, and form a narrow border to the paxillar area, the inferomarginals extending laterally beyond them and forming a scalloped margin to ray. In the interbrachial angle the plates are wider than long, then they become square, and beyond the first third of the ray the length gradually increases over the width, as the plates become smaller and smaller. The plates are tumid, the apex of the tumidity bearing a short conical spine and moving from the middle of the plate (at base of ray) to a little distad of the middle. On the outer fourth of the ray the plates are not tumid and have 2 or 3 spines in a transverse series. The plates are covered with a fine nap of very delicate spinelets, becoming appressed around the base of the spine, and most of them have 1 or 2 small fasciculate pedicellariæ near the inner edge. Inferomarginals on first third of ray equal in width to  $1\frac{1}{2}$  the length; at middle of ray the width only slightly exceeds the length. From this point the ray becomes rapidly very attenuate, and the plates are longer than wide, most of the width being occupied by the actinal face, the lateral facet being low, tumid, and armed with a short oblique comb of 3, distally often 2, slender, tapering, sharp, appressed

spines, the middle or the 2 lower the longest. At the first third of the ray the longest spine equals 2 or  $2\frac{1}{2}$  plates and the comb often is largely abactinal in position, the spines resting on or against the superomarginals. The plates are covered with spaced, rather slender, flattened, appressed spinelets, sometimes squamiform, and the first few plates usually have 1 or 2 fasciculate pedicellariæ near the inner edge, and another at the outer end, near the base of the uppermost lateral spine, this upper pedicellaria persisting to the outer part of the ray.

*P. ædiplax* differs from such species as *euryactis*, *anchistus*, and *luzonicus* in having much narrower and more tumid superomarginals, each of which bears a subcentral conical spine, not an appressed spine or row, near the distal border of the plate. *P. ædiplax* differs from *P. tenuis* in having much smaller and more tumid, armed, superomarginals, and less massive inferomarginals. The side of the ray of *tenuis* at the base is massive and high—higher than the actinal width of the inferomarginals, while in *ædiplax* the border of ray is low, equal to or less than actinal width of the inferomarginals. The ray is slenderer in *tenuis* and the paxillar area much narrower, the paxillæ larger, the lateral spines more numerous, and the actinal inferomarginal spinelets squamiform. *P. multicinctus* belongs to another type, having massive, transversely tumid superomarginals, narrow paxillar area, large independent abactinal pedicellariæ, larger paxillæ, and numerous furrow spines. *P. sulvensis* also has a massive margin to the ray, the superomarginals, especially, being larger than in *ædiplax* and the side wall of ray higher. The paxillar area in *sulvensis* is narrower, and conspicuous, independent, abactinal pedicellariæ are present. Actinally the most conspicuous differences are the wider inferomarginals and longer marginal mouth spines of *sulvensis*, and the slenderer inferomarginal spinelets and conspicuous inferomarginal pedicellariæ of *ædiplax*.

PERSEPHONASTER HABROGENYS, new species.

Resembling *P. ædiplax* but with still slenderer rays, smaller disk, narrower inferomarginal plates, which bear proximally 2 or 3 actinal spinules in addition to the 2 or 3 slender, long, lateral spines; with very small actinal interradiar areas, the plates extending less than half the length of ray; mouth plates small, with 2 series of suboral spines; adambulacral plates spaced, with 5, less often 6, furrow spines. Superomarginal spines proximally 1, distally 2 or 3, the plates markedly convex. No superomarginal, inferomarginal, or subambulacral pedicellariæ.  $R=59$  mm.,  $r=11$  mm.,  $R=5.3+r$ ; breadth of ray at base, 11 or 12 mm. Rays slender, evenly tapered, sharp; interbrachial angles abruptly rounded.

*Type*.—Cat. No. 30527, U.S.N.M.

*Type-locality.*—Station 5114, Balayan Bay, southern Luzon, 340 fathoms, fine sand.

The inferomarginal plates extend slightly beyond the superomarginals and are very narrow, with a tumid outer end, as in *adiplax*. Except for the first 2 or 3 plates, which are wider than long, all the plates are either as wide as long (to about the middle of ray) or narrower than long (outer half of ray). For this genus the inferomarginals are very narrow and form a narrow, slightly beveled border to the actinal area. Lateral spines proximally 3 (with sometimes a slender fourth spine at the upper end of the series), distally 2, slender, slightly curved, appressed, the lowest the longest, and equaling  $2\frac{1}{2}$  to  $2\frac{3}{4}$  plates in length on the proximal half of the ray. On the distal margin of the narrow actinal facet of the plate 2 or 3 much smaller, very slender spinules continue the lateral series. These become so small on the outer third of ray that they merge into the general spinulation, and owing to the extreme narrowness of the plates the lateral comb occupies the whole width. The spinelets covering the outer or lateral face of the plate are delicate, terete, and upright like those of the superomarginals, but actinally they become coarser, sharper, and well spaced. There may be on the proximal plates an additional enlarged spinule near the adoral margin. Several plates in the interradial area, adjacent to the adambulacrals, bear prominent fasciculate pedicellariæ with 4 to 6 swollen spiniform jaws, the calcareous portion being very slender. The furrow spines are 5, or occasionally 6, long, slender, compressed, pointed, membrane-invested, and webbed at base, forming a regular comb with a curved outer margin. The mesial spines are about as long, on the proximal third of the ray, as the neighboring inferomarginal plate. Subambulacral spines very slender, terete, but apparently thick and swollen owing to the translucent tissue investing them. There are about 6 of these forming 2 series on the second and third plates, then on the succeeding plates a single zigzag series, and finally on the outer half or two-thirds of the ray 2 more or less irregular series of 8 to 12 spinules.

This species is an aberrant *Persephonaster* in that its marginal and mouth plates are distinctly smaller than the mean for the genus, and the general habit is slender. The actinal interradial areas are unusually small, and the furrow spines of the adambulacral plates reach the lowest number known in the genus. *P. habrogenys* agrees with *P. gracilis* (Sladen) (formerly *Psilaster gracilis*) in having small mouth plates, but differs in possessing armed superomarginals, smaller disk, higher paxillæ; in having the lateral and ventral facets of the inferomarginals better differentiated, and the long inferomarginal spines lateral in position; in having fewer furrow spines.

## PERSEPHONASTER MONOSTŒCHUS, new species.

Related to *P. croceus* Alcock and Wood-Mason, which it resembles in having, in addition to the appressed inferomarginal spines, a conical erect lateral spine, but differs in having only 1 series of erect superomarginal spines (peculiarly situated), narrower marginals, 8 furrow spines, small actinal interradial areas, and irregularly occurring and smaller, erect, lateral spines.  $R = 45$  mm.,  $r = 8.5$  mm.,  $R = 5.3$   $r$ ; breadth of ray at base, 12 mm. Rays rather slender, with proximally high, lateral walls sloping steeply but not quite perpendicularly; marginal plates massive, tumid, the superomarginals encroaching conspicuously upon the abactinal surface beyond the base of ray. Interbrachial angle abruptly rounded.

*Type*.—Cat No. 30528, U.S.N.M.

*Type-locality*.—Station 5606, Gulf of Tomini, Celebes, 834 fathoms, green mud.

The paxillæ are comparatively large, though having on an average 15 to 18 pointed, slender spinelets about as long as the convex tabulum, 3 to 5 occupying the center. Paxillæ are largest in the interradial regions and adjacent portions of ray, base of tabulum roundish on disk but on ray the plate as well as section of tabulum is elongate-elliptical. On radial region of each ray are several large fasciculate pedicellariæ sometimes broader than paxillæ, composed of 4 to 8 pointed tapering spinelets, much stouter than those of paxillæ, and springing from low plates resembling reduced paxillæ. First 4 or 5 superomarginals with the single upright conical spine practically on upper edge of plate, but with the fifth plate the spine recedes from the inner edge and more and more of the surface of the plate is abactinal. With the eighth or ninth plate the 2 facets are about equal, but distally from this point the dorsal becomes much the wider and the spine which keeps on the well rounded margin between the 2 facets gradually becomes horizontal and has the appearance of being a lateral spine. There is no abrupt fasciolar channel between the plates, the surface sloping upward from either transverse suture to the median line, and the spine is on this ridge. All except the distal inferomarginals are tumid, the ridge of the superomarginals being continued across the lower series, and the ventral margin of the ray is so evenly rounded that the plate is regularly curved from the inner to outer edge. The armature is quite distinct from that of the foregoing species. Just below the outer or upper edge of the plate is a horizontal, erect, conical spine, a little smaller than the corresponding superomarginal. Below this and forming with it a slightly oblique transverse comb are 2 (sometimes 3, and distally only 1) slender, appressed, slightly flattened, sharp spines, the upper about as long as the width of plate. The erect conical spine is often missing. The furrow spines are 8, long, slender, slightly com-

pressed and pointed, in a regular comb with a nearly straight distal margin. Superambulacral spinules 10 to 12, very slender, terete, pointed, in 3 irregular longitudinal series, or in 1 series of 5 near the furrow and the others without very definite order, the size grading from those of first series which are nearly as long as the furrow spines, to the outer, which are subequal to the actinal intermediate spinelets. Some of the proximal plates have fasciculate pedicellariæ with 3 to 5 shortened, sharp, spiniform jaws.

TRITONASTER EVORUS, new species.

R=31 num., r=7 mm., R=4.4 r; breadth of ray at base, 7.5 mm. Rays pointed, fairly stout, very evenly tapering from narrow base; interbrachia abruptly rounded; abactinal integument thin, slightly inflated; paxillæ small, largest on borders of paxillar area, to which the papulæ are confined; marginal plates massive; superomarginals forming a tumid border to paxillar area, each with a small conical upright spine; inferomarginals with very tumid outer ends bearing, proximally, 2 curved parallel combs of setalike spines (one covering the other) and, distally, 1 such comb; adambulacral plates with 3 long furrow, and 12 to 15 delicate subambulacral spines, the latter often forming fasciculate pedicellariæ. Differing from *T. craspedotus* in the much larger, tumid superomarginals, smaller paxillæ, double proximal combs of lateral spines, fewer adambulacral spines and fewer enlarged teeth.

*Type*.—Cat. No. 30529, U.S.N.M.

*Type-locality*.—Station 5476, off southeastern end of Luzon (vicinity of San Bernardino Strait), 270 fathoms, fine sand; bottom temperature, 48.3° F.

The paxillæ are rather low parapaxillæ, the summit of the tabulum being convex and narrower than the base. The larger paxillæ have 1 to 4 central, delicate, minutely thorny spinelets and 6 to 9 peripheral, while the small ones have 1 to 3 central and 5 to 8 peripheral. Superomarginal plates, 24 to a ray, are, unlike those of *craspedotus*, robust to the end of the ray, and are so shaped that they form a raised angular or tumid border to the paxillar area. The plates are wider than long, and each has a lateral and a dorsal face, the latter being about square, and the former longer than high beyond the basal fourth of ray. The general surface of plate is covered with well-spaced, tiny, upright spinelets, very fine about the borders of the plate and gradually becoming thimble-shaped at the center. On the lateral face of many plates are 1 or 2 small fasciculate pedicellariæ with about 6 tiny spinelets for jaws. The fascioles between the plates are very rudimentary. The inferomarginals have a very convex outer end, which defines the ambitus and bears a perpendicular, curved comb of delicate setalike spines. On the

second to fifth plates this comb covers a second parallel comb of smaller spines, as in *Ctenophoraster*, and some species of *Persephonester*. Proximally the first comb consists of about 5 larger spines, the third from the upper the longest; and, forming a continuous series with these on the distal margin of the actinal surface, 3 or 4 smaller and more delicate ones. Beyond the eighth or ninth plate only the lateral comb remains and consists of 5 or 4 spines, diminishing to 3 or 4 at the very tip of ray. Owing to the tumidity of the outer end of the plate, 2 or 3 of these spines are dorsal in position and are pressed against the sloping side wall of the superomarginals. The second comb is confined strictly to the first 4 or 5 plates, and to the outer end, forming a parallel series between the base of the regular comb and the distal edge of the plate.

DIPSACASTER DIAPHORUS, new species.

Similar in form to *D. sladeni* but differing in having short, thick, clavate, or subterete, thorny paxillar spinelets, more numerous adambulacral spinules, a small madreporic body, and less conspicuous marginal spinules; all the shorter spines and spinelets thorny; paxillæ with 20 to 25 spinelets; furrow spines 8 or 9, very slender, pointed, slightly compressed; subambulacral spinules 15 to 20 arranged in series, or forming a sort of rosette-like group on the convex surface of the plate; madreporic body small. Rays rather slender, disk large, interbrachia abruptly rounded.  $R=31$  mm.,  $r=10$  mm.,  $R=3$  r; breadth of ray at base, 11.5 mm.

*Type*.—Cat. No. 30530, U.S.N.M.

*Type-locality*.—Station 5526, between Siquijor and Bohol Islands, Philippine Islands, 805 fathoms, green mud and globigerina; bottom temperature, 52.3° F.

The paxillar area is compact, and the paxillæ are comparatively large, with rather short pedicels crowned by a capitate group of 20 to 25 thick clavate or cylindrical, round-tipped, minutely thorny spinelets, about as long as the pedicels, and relatively fewer and thicker than usual in this genus. The superomarginals, 23 in number, are nearly square, abactinal in position, and covered with slightly spaced spinelets similar to those of the paxillæ. Inferomarginals corresponding to superomarginals plate for plate, and covered with spaced, appressed, slender, sharp, sometimes flattened and squami-form spinelets, becoming a tuft of longer spinules on the outer end. Two or 3 of these are larger than the rest, arranged in a transverse series, and are similar to the lateral spines of *D. sladeni*, though less conspicuous. The actinal intermediate plates have fairly high ridges crowned by 15 or more slender, very thorny spinelets, larger at the tip than at base, and longer than the inferomarginal spinelets. An odd interradian series of about 4 plates extends from the pair of intermediate plates back of the jaws to the margin.



## PATAGIASTER SPHÆRIOPLAX, new species.

Differing from *P. nuttingi* Fisher in having shorter, broader rays, larger paxillæ with more numerous granules; in having the paxillæ in a definite radial, and parallel longitudinal series; in having broader marginal plates and slenderer actinal spinulation.  $R = 28$  mm.,  $r = 12$  mm.,  $R = 2.3 r$ ; breadth of ray at base 13.5 mm. Disk large, rays short, tapering from wide rounded interbrachia to a pointed extremity; general form depressed; sides of ray rather thin, rounded; larger paxillæ with 30 to 40 elongate, regular, bead-like granules surrounded by a peripheral series of numerous, slender, short spinelets, some of which are intermediate in form with the central granules; furrow spines slender, pointed, slightly compressed, in a regular comb of 6, sometimes 7, the contour of the distal margin being curved; sub-ambulacral spines 12 to 16 slender, terete, with prickly tips, usually in 3 longitudinal series, the 3 or 4 spines back of the furrow series being nearly as long as furrow spines; actinal intermediate plates with a conspicuous keel, and carrying a paxilliform group of 15 to 18 slender, rather long spinelets, those in the center the stoutest (longer and slenderer than in *P. nuttingi*).

*Type*.—Cat. No. 30531, U.S.N.M.

*Type-locality*.—Station 5178, vicinity of Romblon Island, Philippine Islands (lat.  $12^{\circ} 43' N.$ ; long.  $122^{\circ} 06' 15'' E.$ ), 78 fathoms, fine sand.

## Genus DYTASTER Sladen.

## KOREMASTER, new subgenus.

Differs from typical *Dytaster* in having a very weak abactinal integument, *Astropecten*-like paxillæ with well-developed pedicels and relatively long, slender spinelets; and in having the marginal fascioles well developed. Pedicellariæ, marginal armature, and adambulacral armature, gonads and alimentary system as in *Dytaster*. An odd interradiial series of actinal intermediate plates, often irregular, is present and the madreporic body is smaller and less densely covered with paxillæ than in *Dytaster*.

*Type of the subgenus*.—*Dytaster* (*Koremaster*) *evaulus*, new species.

## DYTASTER (KOREMASTER) EVAULUS, new species.

$R = 62$  mm.,  $r = 15.5$  mm.,  $R = 4 r$ ; breadth of ray at interbrachium 19 mm., at tenth superomarginal, 9 mm.; interbrachium arcuate or rounded-angular; rays arcuately tapering and narrow beyond the basal fourth; abactinal integument inflated; paxillæ well developed, often penicillate, with fairly tall pedicels and slender, pointed, thorny spinelets; abactinal, globose pedicellariæ; well developed marginal fascioles; marginal plates small, block-like, with a stout conical spine; actinal intermediate pedicellariæ; furrow spines much compressed, 7

or 8; subambulacral spines, 6 to 10, 1 being enlarged; usually 1 or 2 subambulacral pedicellariæ; first adambulacral plate compressed; marginal mouth spines much compressed.

*Type*.—Cat. No. 30532, U.S.N.M.

*Type-locality*.—Station 5606, Gulf of Tomini, Celebes, 834 fathoms, green mud.

This species is remarkable for the typical paxillæ and well developed marginal fascioles. It is not closely related to any described species. Among the forms dredged by the *Challenger* it shows most resemblance to *D. spinosus*, but has perpendicular sides to the ray, taller, more penicillate paxillæ, and characteristic pedicellariæ. These on the abactinal surface, resemble rather large globular granules split nicely into 3 to 5 sections.

The adambulacral plates are narrow, being much longer than wide, with a rounded furrow margin bearing 7 or 8 fairly long, bluntly pointed, compressed spines, widened and blade-like at the base, and sometimes rather abruptly constricted near the tip, the median spines being slightly the longest and all forming a vertical comb. Close to these on the surface of the plate is an irregular longitudinal series of 6 to 10 cylindrical, pointed spines of which one near the center is enlarged and subequal to or longer than the furrow spines. But on the outer part of the ray the other spines are abruptly smaller, one-half to two-thirds the length of the larger, and not clearly arranged in a series. Most of the plates bear 1 or 2 prominent pedicellariæ, with usually 3 jaws, slightly longer than those of the actinal interradial areas. The latter resemble, in miniature, flower buds with 4 to 8 fleshy petals, and are found on a majority of the actinal intermediate plates.

A large abactinal paxilla has 15 to 20 spinelets of which 3 to 5 stand on the convex top of the pedicel and the others, with a slight basal web, form a peripheral series. The paxillæ resemble, on a small scale, those of *Solaster papposus*.

### Family GONIASTERIDÆ.

#### MIMASTER NOTABILIS, new species.

Differing from *M. tizardi* in having much slenderer rays, more numerous paxillar spinelets, more prominent paxilliform marginal plates, a narrower actinal intermediate area on ray, and fewer adambulacral spinelets.  $R=104$  mm.,  $r=35$  mm.,  $R=3$  r; breadth of ray at base, 39 mm. Paxillæ slightly spaced, with upward of 75 delicate, terete, pointed spinelets, either closely appressed in a cylindrical upright group, or radiating and forming a subglobose crown; marginal plates small, paxilliform, the inferomarginals the larger, about as high as the length of the base, and standing out horizontally from ambitus, the crown of spinelets compressed and

wider than long; actinal intermediate plates in 10 or 11 very regular chevrons, and extending to the end of the ray; half way along ray about 5 actinal intermediate plates in a transverse series (8 or 9 in *tizardi*); intermediate plates with spaced cylindrical, upright paxilliform groups of slender spines; adambulacral armature resembling that of *M. tizardi*, but with 13 or 14 (instead of 15 to 20) spinelets, 2 or 3 of which, about  $1\frac{1}{2}$  plates in length, and considerably stouter than the rest, occupy the furrow margin.

*Type*.—Cat. No. 30533, U.S.N.M.

*Type-locality*.—Station 5630, vicinity of Batjan Island (south of Patiente Strait), Molucca Islands (lat.  $0^{\circ} 56' 30''$  S.; long.  $128^{\circ} 05'$  E.), 569 fathoms, coral sand, mud.

PSEUDARCHASTER OLIGOPORUS, new species.

Nearest to *Ps. pectinifer* Ludwig and *Ps. dissonus* Fisher.  $R=87$  mm.,  $r=21$  mm.,  $R=4.1$  r; breadth of ray at base, 24 mm.; rays slender, long, and very attenuate at the extremity; side of ray low, rounded; marginal plates small, especially distally, where superomarginals are confined to side wall of ray and are longer than wide, square, or slightly wider than long; papular area restricted to center of disk and petaloid radial areas extending about  $\frac{1}{4}$  the length of ray; abactinal plates tabulate on papular area, the roundish tabula low, spaced, and bearing 20 to 30 polygonal granules; outside of papular area, plates elliptical or oblong, arranged in oblique transverse series and with very low tabulum, or distally none; superomarginal plates with coarse, spaced, round granules; inferomarginals with pointed, conical, appressed spinelets, and proximally 8 to 12 appressed, sharp spines in a zigzag transverse series, these becoming reduced to 1 or 2 toward the extremity of ray; actinal intermediate plates in 5 chevrons, the series adjacent to adambulacrals with the transverse sutures armed with fasciolate pectinate pedicellariæ, the spinelets being short and broad-tipped; furrow series angular with 8 or 9 short, sometimes slightly compressed, blunt or bluntly pointed spines and 1 or 2 tapering, pointed, subambulacral spines, surrounded by 5 to 10 shorter, spaced, pointed spinelets.

*Type*.—Cat. No. 30534, U.S.N.M.

*Type-locality*.—Station 5609, Gulf of Tomini, Celebes (lat  $0^{\circ} 11'$  S.; long.  $121^{\circ} 16'$  E.), 1,092 fathoms, green mud; bottom temperature,  $36.3^{\circ}$  F.

This abyssal form differs from *Ps. pectinifer* and *Ps. dissonus* of the east and north Pacific in having longer and slenderer rays, the distal portion being especially attenuate; smaller marginal plates; a very restricted papular area; smaller and distinctly spaced tabulate

plates on the parietal area, the others being low and not tubular, and shorter furrow spines.

The anterior long legs and small marginals will readily separate *Aphrodacna* from *Paralichia*, *Acrotaria*, *Acrotis*, *Acrotomaria* and *Proclitus*. *Ps. rosea* (Block) from the Laccadive Sea, 700 fathoms, is a long-legged form,  $\bar{L}$  equalling 1:2. Kuster states that in the type there are no intermarginal spines, merely granules, and Block describes the acanthopora plates as having usually 3 unequal longitudinal series of close proximal granules. Presumably there are no enlarged subacanthopora spines. This species was described as a *Yuccellus*. Kuster states that it is a *Pseudobalanus*. From the description it would appear to bear considerable resemblance to the new *Aphrodacna* herein described. It is certainly very different from *Ps. oligopora*, which has armed intermarginals and prominent subacanthopora spines.

*SPEROGONASTER MICROCRACOTS*, new genus.

$\bar{L}$  = 43 mm.,  $\sigma$  = 21.5 mm.,  $\bar{E}$  = 1.4  $\sigma$ ; breadth of eye at mid-interbrachium, 13 mm. Disk fairly large with open rounded interbrachium; legs slender and pointed; all plates covered with a close tessellation of flat-topped or slightly convex polygonal granules; no spines except on acanthopora and mouth plates; tubular area narrower on legs than width of broad armed supermarginals; acanthopora plates compactly placed with usually 4 to 5, but sometimes as many as 11 polygonal crowded granules, or on outer part of ray, 4 or 5 marginals much broader than long forming a smooth evenly rounded margin to ray; normal intermediate plates restricted to disk and evenly granular; furrow margin slightly convex proximally, decidedly convex distally with 7 to 8 short, stubby spinules and 13 to 14 compact polygonal subacanthopora granules on 4 or 5 longitudinal series; no specialized subacanthopora spines; no pedicellate acanthopora structure resembling that of *Paralichia*.

Type.—Cat. No. 10535, U. S. N. M.

Type-locality.—Station 5643, Basin Street, Culebra Is., 3° 14' S., long 121° 30' E., 350 fathoms, green mud, bottom temperature, 10.5°; 1 specimen.

This species differs from *Aphrodacna gracilis* Slater (Cat. No. 10506 fathoms) in having larger, fewer and more compact acanthopora granules, polygonal in form; shorter marginal plates armed with faintly polygonal compact granules, spinules on intermarginals of *parietal*, compact polygonal normal intermediate and subacanthopora granules, rather than spinules; and in lacking the post-acanthopora tubules.

*Aphrodacna* agrees with *Pseudobalanus* in general appearance and in having an odd tooth at the inner end of the combined mouth

plates. It differs in having a straight or only slightly curved furrow margin to the adambulacral plates, an even comb of furrow spines, and no specialized or enlarged subambulacral spine or spines. The two genera are closely related.

Genus PARAGONASTER Sladen.

KEY TO THE SPECIES AND SUBSPECIES OF PARAGONASTER HEREIN DESCRIBED.

a. Proximal plates of the single series which separates the superomarginals wider than long, and conspicuously wider than the adjacent radial plates of disk; peripheral granules of the plates of popular area smaller than the central granules; the two sorts subequal elsewhere; central granules slightly spaced, not compact; numerous inferomarginal and actinal intermediate spines; fasciolate pedicellariae between nearly all the adambulacral plates. . . . . *stenipis* hypacanthus.

b. Proximal plates of the radial series of ray narrower than long and narrower than the adjacent radial plates of disk; peripheral granules of all the abactinal plates smaller than the central, which are very compactly placed; very few inferomarginal and no actinal intermediate spines; incipient fasciolate pedicellariae between the first few adambulacral plates only, rudimentary distally.  
 . . . . . *stenostichus*.

PARAGONASTER CTENIPES HYFACANTHUS, new subspecies.

Closely resembling *P. ctenipes* Sladen, but differing in having more numerous granules on the abactinal plates, more numerous and conspicuous inferomarginal spinules and smaller and more distantly spaced inferomarginal granules, a prominent central spine on many of the actinal intermediate plates, and proximally 2 enlarged subambulacral spines.  $R=88$  mm.,  $r=19$  mm.,  $R=4.6 r$ ; breadth of ray at mid-interbrachium, 22 mm.; at inner limit of the single row of abactinal plates (distal margin of fourth superomarginal plate) 12.5 mm., or length of first 6.3 superomarginals measured on ambitus (varies to 5); general form as in *ctenipes*, but rays a little slenderer; abactinal plates with 15 to 25 central and 25 to 30 peripheral granules, which are slenderer on the popular areas; distal carinal plates of disk with upward of 40 central and 35 to 45 peripheral granules; inferomarginal plates with proximally 6 to 10 appressed sharp spinules, reduced to 3 or 4 at middle of ray, then 2, a single spinule persisting to near end of ray; furrow spines 7 or 8, continued along the transverse margins as smaller interlocking spinelets; subambulacral spines prominent, slender, tapering, sharp proximally 2, distally 1; in small specimens 1 throughout.

Type.—Cat. No. 30536, U.S.N.M.

Type-locality.—Station 5273, off western Luzon, 27 miles southwest Corregidor Light, 114 fathoms, mud, shells, and coral sand.

PARAGONASTER STENOSTICHUS, new species.

Differing from *P. ctenipes* in having the abactinal plates of slender portion of ray narrower than long, and proximally narrower than the adjacent radial plates of disk, instead of broader; in having more

numerous, crowded, and coarser central granules, and slenderer peripheral granules; and in having narrower adambulacral plates, which lack the characteristic fasciolate pedicellariæ of *ctenipes*, except in a less specialized form on the first few plates.  $R=45$  mm.,  $r=12.5$  mm.,  $R=3.6$  r; breadth of ray at mid-interbrachium, 14 mm.; at distal margin of fourth superomarginal (the proximal end of the slender portion of ray) 8 mm., or length of first  $5\frac{1}{2}$  superomarginals measured on ambitus. Abactinal plates strongly tabulate with convex, subhexagonal or roundish crowns, having in the radial series 18 to 25 close-set, coarse, irregularly polygonal, central granules and 20 to 25 smaller, slenderer, peripheral ones; plates of the single (radial) series which separate superomarginals of ray, slightly tabulate proximally, longer than wide throughout, with granules similar to those of the plates of disk, and all narrower than the radials of disk; superomarginals broad, all wider than long, slightly tumid, with close-set, coarse, polygonal granules; inferomarginals with subsquamiform granules ventrally and 2 or 3 short appressed lanceolate spinules in a group or transverse series on inner half of the proximal plates; adambulacrals only a trifle wider than long, with angular furrow margin, and 7 or 8 furrow spines in a palmate series; first 4 plates with aboral facet of margin much the longer; subambulacral spinelets 12 to 15 with 1 enlarged, tapering, sharp spine; oral spines 8 or 9, on angular margin of mouth plates, those at apex of angle the shortest.

*Type*.—Cat. No. 30537, U.S.N.M.

*Type-locality*.—Station 5289, Verde Island Passage, north coast of Mindoro, 172 fathoms, broken shells, sand.

#### PERISSOGONASTER, new genus.

Differing from *Paragonaster* in having an odd interradial marginal in both series, and an incomplete odd interradial series of actinal intermediate plates; papulæ distributed all over disk and as far along radii as the adradial plates extend.

*Type of the genus*.—*Perissogonaster insignis*, new species.

#### PERISSOGONASTER INSIGNIS, new species.

Similar in general appearance to a *Paragonaster* with unusually large disk, stout rays, and the adradial plates extending in large specimens a third to two-fifths length of ray.  $R=113$  mm.,  $r=35$  mm.,  $R=3.2$  r; breadth of ray at mid-interbrachium, 40 mm., thence tapering gradually to the bluntly pointed extremity; interbrachia wide and arcuate; superomarginals 37 to 42, broader than long, and increasing slightly in width up to the tenth or twelfth, and beyond the eighth to seventeenth separated only by the rectangular carinal plates; odd interradial plate similar to the rest; plates covered with depressed, roundish, convex, slightly spaced granules, the outer end

being armed with an inconspicuous, short, appressed, slender, sharp spine extending nearly to end of ray; inferomarginals narrower on outer two-thirds of ray than superomarginals and covered with conical granules; in addition to these, proximally 6 to 10 and distally 2 to 4 slender, sharp, appressed spines, either scattered or in 1 or 2 transverse series; abactinal plates paxilliform, with compact subhexagonal crowns, very regularly arranged in series parallel to the radial; an average radial plate with 9 to 12 roundish or slightly polygonal, spaced, central granules and 20 to 25 flattened, truncate, oblong, or slightly tapered, smaller peripheral ones, these numbers increasing on the distal carinal plates and decreasing on the dorso-laterals; papulae distributed all over dorsal surface as far distad as there are more than 1 series of abactinal plates; actinal intermediate plates, each with an appressed, sharp, spine; adambulacral plates with an angular but not very salient furrow margin bearing 6 or 7 short, blunt spines; subambulacral spines 1 or 2, sharp, appressed, surrounded by 5 to 8 elongate, subconical granules, in addition to 3 or 4 on outer margin, and 3 to 6 on each transverse margin, the latter often forming a fasciolate pedicellaria over the suture.

*Type*.—Cat. No. 30538, U.S.N.M.

*Type-locality*.—Station 5113, Balayan Bay, Southern Luzon, 159 fathoms, on a bottom of dark green mud.

This curious genus bears about the same relation to *Paragonaster* that *Prionaster* bears to *Goniopecten* or *Pectinidiscus* to *Ctenodiscus*. In all the characters except those mentioned in the diagnosis it is essentially similar to *Paragonaster*.

#### Genus ROSASTER Perrier.

*Rosaster* PERRIER, Expéd. sci. du Travailleur et du Talisman, 1894, p. 386.—Type, *Pentagonaster alexandri* Perrier.

*Nereidaster* VERRILL, Trans. Conn. Acad., vol. 10, 1899, p. 186.—Type, *Nymphaster symbolicus* Sladen.

I have for some time suspected that *Rosaster alexandri* Perrier might be closely allied to the section of *Nymphaster* called *Nereidaster* by Verrill in 1899 (type, *Nymphaster symbolicus* Sladen). In 1906 I raised *Nereidaster* to generic rank, including in it a species, *Nereidaster bowersi*, which proves not to be congeneric with the type of *Nereidaster*. It is this misconception of *Nereidaster* which I incorporated in a key to the genera of Goniasteridæ in the Asteroidea of the North Pacific, page 170.

I made a cursory examination of *Rosaster alexandri* several years ago and thought I found rudimentary superambulacral plates. These are not present. What I saw, on closer examination, proves to be curious spiny outgrowths from the lower end of the small ambulacral ossicles. The arrangement of the gonads in this species as well as

the presence of internal abactinal ossicles, similar to those of "*Nymphaster*" *symbolicus* (and of the species herein described), leaves no doubt that *Nereidaster* and *Rosaster* are the same. *Rosaster symbolicus* (Sladen) is represented in the collection by 2 adult specimens.

A further discussion of the anatomy and relationships will have to be deferred until the final report. Meanwhile the following diagnosis of *Rosaster*, drawn up with reference to the seven known species, may be useful.

Goniasteridæ resembling *Mediaster* in having internal supplementary ossicles connecting the abactinal plates and in having the gonads arranged in series extending along the rays, but differing in lacking rudimentary superambulacral ossicles, and in having the superomarginals in contact medially over a considerable portion of the ray (if separated, then only by a single series of small plates for a considerable distance); pedicellariæ always slender, tong-shaped, not of the low-bivalved form. Resembling *Nymphaster* in form but differing in the serial arrangement of gonads, in having strongly tabulate subpaxilliform abactinal plates, and in lacking the strongly angular furrow margin to the adambulacral plates. Form stellate, with well-developed rays; superomarginals in contact distally, sometimes for a considerable portion of ray; abactinal plates strongly tabulate on papular areas and with internal radiating connecting ossicles; actinal interradiial areas large; adambulacral plates with a straight or slightly curved furrow margin bearing a regular comb of few to many, usually compressed, spines, and spaced from these a subambulacral series of spines, more or less prismatic, the outer part of the plate being occupied by granules sometimes graduated in size toward the subambulacral series of spines; pedicellariæ rather slender, spatulate, and intrenched; no superambulacral ossicles; gonads in several independent tufts which extend in a series along the ray, close to, or removed from, the margin and usually parallel to the radius; tube feet without deposits.

KEY TO THE KNOWN SPECIES OF ROSASTER.

- a<sup>1</sup>. Superomarginals contiguous for nearly half to more than half of R; not separated by a single series of small plates for a considerable distance.
- b<sup>1</sup>. Furrow spines 4 or 5, at least few in number; size small.
- c<sup>1</sup>. Abactinal paxilliform plates roundish, with subequal, thorny spinelets; granules of marginal plates longer than diameter, thorny and resembling very short spinelets; furrow spines relatively long, slender, compressed. .... *alexandri*.
- c<sup>2</sup>. Abactinal plates hexagonal, with unequal granules, the peripheral on the lateral edges of the radial and adradial plates being enlarged and opercular, covering the papulæ beneath; granules of marginal plates small, depressed, hemispherical, broader than high; furrow spines short. .... *nannus*.
- b<sup>2</sup>. Furrow spines 7 or 8 to 14 or 15; size small to large.



- c<sup>1</sup>. Size small; radial tabulate plates roundish, a few distal abactinal plates isolated singly between consecutive pairs of contiguous superomarginals; furrow spines 7 or 8; subambulacral spines and granules in 3 series....*confinis*.<sup>1</sup>
- c<sup>2</sup>. Size medium or large; radial tabulate plates hexagonal.
- d<sup>1</sup>. Furrow spines 14 or 15; large radial plates with 12 to 23 central granules.  
.....*mimicus*.
- d<sup>2</sup>. Furrow spines 8 to 10; large radial plates with 2 to 4 central granules.  
.....*bipunctus*.
- a<sup>2</sup>. Superomarginals separated on outer part of ray by a single series of abactinal plates, but the last few plates may be in contact medially.
- b<sup>1</sup>. Size small; distal marginals with a small central tubercle; marginals tumid; furrow spines 4 or 5.....*mamillatus*.
- b<sup>2</sup>. Size large; distal marginals not tuberculate; marginals not individually tumid; furrow spines 8 to 12.....*symbolicus*.

## ROSASTER NANNUS, new species.

A small species resembling *R. confinis* (Kœhler), but differing in having larger, hexagonal, radial plates, with differently formed and characteristic marginal granules, fewer furrow spines (4 or 5) and 2 instead of 3 series of subambulacral spines and granules. Disk stellato-pentagonal, the rays at first tapering abruptly to the third superomarginal, which meets its fellow medially, then very gradually, the extremity being blunt and the general form resembling that of *Paragonaster*; breadth of ray at inner end of third superomarginal equaling first 2½ superomarginals measured on ambitus; radial plates large, with large, valve-like granules on the lateral borders, and smaller ones on the transverse margins; furrow spines 4 or 5; subambulacral armature in 2 longitudinal series, the inner consisting of 3 or 4 spines; consecutive plates of median radial series joined by 2 internal ossicles, and joined to the adradials by 2 transverse ossicles, the former being absent on the adradial series. R = 24 mm., r = 6.5 mm., R = 3.7 r; breadth of ray at mid-interbrachium, 7 mm.

*Type*.—Cat. No. 30539, U.S.N.M.

*Type-locality*.—Station 5152, Tawi Tawi Group, Sulu Archipelago (lat. 5° 22' 55" N.; long. 120° 15' 45" E.), 34 fathoms, white sand.

*Dorigona confinis* Kœhler has been included in this genus only on the evidence of external characters. It appears to be related to *R. nannus*.

Although the specimens are small the gonads are relatively very large, and fill up most of the cœlom of the base of the ray. They consist of thick unbranched or bifid sacs in clusters of 1 to 5, these extending in a series close to the margin as far as the third superomarginals, or until the latter join medially. There seem to be at least 5 of these clusters in each series.

The rays are formed for the greater part of their length, above, by the superomarginals, which are all longer than wide, as seen from the

<sup>1</sup> *Dorigona confinis* Kœhler, An account of the shallow-water Asteroidea. Echinodermata of the Indian Museum, part 6, Asteroidea (II), June, 1910, p. 57.

dorsal side, and rather evenly and fully curved from the inner to the outer margin, the lateral face being only a trifle narrower than the dorsal. Plates 13 in type, increasing in size up to the third which meets its fellow medially. This plate is slightly longer than wide (or the 2 dimensions subequal) as seen from above, and thence the plates are increasingly longer than wide. The first 3 plates are shorter than the chord of the extreme width, however, and in the fourth the length about equals chord of width. The plates are covered with slightly spaced, depressed, subspherical granules, subequal to those occupying the center of the abactinal plates. Beyond the second inferomarginal all are normally longer than wide, as seen from below. A small entrenched 2-jawed pedicellaria is found on some of the proximal plates of the type, but not in other specimens.

ROSASTER MIMICUS, new species.

Resembling somewhat *R. bipunctus* (Sladen), but differing in having sharper rays, compacter paxillæ with numerous crowded central granules, more numerous, compressed, furrow spines (12 to 14), more numerous subambulacral spines and granules, and more numerous oral spines. Form stellate with arcuate interbrachia and gradually tapering rays; sides of ray and disk perpendicular with a longitudinal depression; breadth of ray, measured at proximal suture of first pair of superomarginals which meet medially equal to first  $3\frac{1}{2}$  or 4 superomarginals measured on ambitus; abactinal plates strongly tabulate on papular areas and with upward of 23 central and 25 peripheral granules on the radial series; abactinal, marginal, actinal intermediate, and adambulacral pedicellariæ; subambulacral armature a series of prismatic spines and 2 or 3 parallel series of granules; furrow spines 12 to 14.  $R=56$  mm.,  $r=21$  mm.,  $R=2.7 r$  (cotype); in type  $R$  = probably 75 mm. and  $r=23$  mm.

*Type*.—Cat. No. 30540, U.S.N.M.

*Type-locality*.—Station 5281, between Lubang and Luzon (lat.  $13^{\circ} 52' 45''$  N.; long.  $120^{\circ} 25'$  E.), 201 fathoms, dark gray sand; bottom temperature,  $50.4^{\circ}$  F.

ROSASTER MAMILLATUS, new species.

Differing from *R. alexandri*, and other small species, in having the superomarginals beyond the third plate separated by a single series of abactinal plates nearly to extremity of ray, and in the presence on the distal marginal plates of a small central tubercular granule, larger than any of the other granules.  $R=21$  mm.,  $r=7.5$  mm.,  $R$  = a little less than  $3 r$ ; breadth of ray at mid-interbrachium, 7 mm. Superomarginals massive, tumid, 13 in number, and covered with roundish, rather coarse, subtruncate, slightly spaced granules, the peripheral being largest on the dorsal facet of plate; the 5 or 6 superomarginals preceding the last with an enlarged, subcentral, tubercular granule;

inferomarginals corresponding to superomarginals, tumid, the last 6 or 7 with a subcentral enlarged granule. Area of abactinal plates stellate; median radial plates wider than long, subhexagonal, the others subcircular, all tabulate; granules relatively coarse, the peripheral flattened, finger-nail-shaped, 10 to 12 on the radial plates and 8 to 10 on laterals; central granules roundish, low, 2 or 3 to 6 on radial plates, 1 to 3 on lateral plates; carinal plates of attenuate part of ray small, those opposite the transverse sutures of superomarginals elliptical or lozenge-shaped, the alternate plates smaller and oblong; abactinal plates with a few upright conspicuous pedicellariæ, with 2 oblong or slightly tapered jaws. Adambulacral plates with a slightly curved furrow margin and 4 or 5 subequal, slightly compressed, blunt, furrow spines; subambulacral spines 3 or 4 in an oblique longitudinal series spaced from furrow, followed by proximally 3 or 4 granules in a single series, or distally 5 or 6, usually in 2 series. Oral spines 8, similar to the adambulacral furrow spines.

*Type*.—Cat. No. 30541, U.S.N.M.

*Type-locality*.—Station 5481, Surigao Strait, off Cabugan Grande Island, Leyte, 61 fathoms, sand, shells, gravel.

This species agrees with *R. symbolicus* in having the superomarginals of the ray, with the exception of the last 2 or 3, separated by a single series of abactinal plates, but differs in having conspicuously tumid marginal plates, the distal half dozen of each series bearing a small central tubercle. The furrow spines are 4 or 5 instead of 8 to 12, and the species is small, while *symbolicus* is large.

### Genus NYMPHASTER Sladen.

#### KEY TO THE SPECIES OF NYMPHASTER HEREIN DESCRIBED.

- a*<sup>1</sup>. Marginal mouth spines (bordering on mouth of ambulacral furrow) 6 or 7, exceptionally 8 (if 8, then rays not conspicuously slender, but if measured at proximal suture of the first pair of superomarginals which meet medially, equalling length of first 3½ to 4½ superomarginals measured on ambitus); some of the radial plates wider than long; mouth plates small, and rays stout, the inferomarginals extending laterally beyond superomarginals.
- b*<sup>1</sup>. Mouth plates nearly or quite inclosed by the first pair of adambulacrals; numerous subambulacral spines; abactinal granules mucronate. . . . .*mucronatus*.
- b*<sup>2</sup>. Mouth plates not inclosed; subambulacral spines few or none (granules only); abactinal granules at best only incipiently mucronate, and these few in number.
- c*<sup>1</sup>. Five longitudinal series of abactinal radial plates with the distal as well as proximal plates obviously wider than long; no marginal or abactinal pedicellariæ; inferomarginals and superomarginals wider, the latter on rays, the former on disk; width of ray as measured in *a*<sup>1</sup>, equaling first 4 or 5 superomarginals. . . . .*curyplox*.
- c*<sup>2</sup>. Radial plates not so obviously wider than long, the difference showing on the proximal plates of the radial areas rather than on the distal; numerous abactinal and a few marginal pedicellariæ; superomarginals narrower on ray and inferomarginals narrower on disk; ray measured as in *a*<sup>1</sup> equaling first 3½ superomarginals . . . . .*dyscritus*.

- a*<sup>2</sup>. Marginal mouth spines 8 to 15 (if the lowest number, or exceptionally less, then rays also very slender throughout).
- b*<sup>1</sup>. Abactinal radial plates conspicuously wider than long (much as in *mucronatus*); rays very slender.....*leptodomus*.
- b*<sup>2</sup>. Abactinal radial plates roundish or hexagonal, not conspicuously broader than long.
- c*<sup>1</sup>. Second superomarginals meeting in median line across ray (4 superomarginals in each interbrachium); inferomarginals of ray very narrow and long, the length at middle of ray exceeding the height (or thickness) of lateral face of ray; rays slender and delicate; oral spines, 10 or 9.....*atopus*.
- c*<sup>2</sup>. Fourth, fifth, and sixth superomarginals meeting in median line across ray (sometimes third in young specimens), and therefore 6 to 12 superomarginals to each interbrachium); length of inferomarginals at middle of ray equal to or less than height of lateral face of ray.
- d*<sup>1</sup>. Ray broader at base, measured as in *a*<sup>1</sup> equaling first 4½ superomarginals; superomarginals very broad, not tumid; oral spines, 10 to 12; furrow spines 10; inferomarginal plates of interbrachia extending laterally beyond superomarginals.....*moluccanus*.
- d*<sup>2</sup>. Ray narrow at base, measured as in *a*<sup>1</sup> equaling first 3 to 4 superomarginals; if approaching *d*<sup>1</sup>, then superomarginals tumid; in interbrachia superomarginal plates extending laterally beyond inferomarginals.
- e*<sup>1</sup>. Marginal plates individually tumid; no adambulacral pedicellariæ; mouth spines 9 or 10; furrow spines 9 to 11 at middle of ray....*arthrocnemis*.
- e*<sup>2</sup>. Marginal plates not individually tumid; adambulacral pedicellariæ; furrow spines at middle of ray more than 11.
- f*<sup>1</sup>. Dorsolateral angle of ray about 90°, square cut; dorsal surface plane; marginal granulation closer; sixth and sometimes fifth superomarginal longer than width of its dorsal surface; 10 inferomarginals corresponding to about 16 adambulacrals; mouth spines 9 to 11.....*meseres*.
- f*<sup>2</sup>. Dorsolateral angle of ray more rounded, the dorsal surface being convex; marginal granules more spaced; ninth or tenth superomarginal longer than width of its dorsal surface; 10 inferomarginals corresponding to 13 or 14 adambulacrals; mouth spines 12 to 15.....*habrotatus*.

NYMPHASTER EURYPLAX, new species.

General form similar to that of *N. diomedæ* Ludwig and *N. ternalis* (Perrier), but superomarginals with plane abactinal surface, not tumid; rays broad at base and actinal surface conspicuously wider than abactinal, the edges between the 4 faces of the ray being abruptly angular; disk arcuately pentagonal, gradually merging into rays at corners; extreme width of ray, measured at proximal suture of the first pair of superomarginals, which meet medially, equaling length of first 4 or 5 superomarginals, measured on ambitus; inferomarginals broad; rays not sunken along median radial line; inferomarginals broader than superomarginals on disk, but narrower on ray; radial and adradial abactinal plates broader than long, hexagonal, elliptical, and lozenge-shape; adambulacral plates with very strong furrow angle and 9 or 10 furrow spines, the apices of the angles of opposite plates meeting in middle of furrow and segregating consecutive pairs of tube-feet beyond proximal fourth of furrow; mouth plates with 6 to 8 marginal spines; no pedicellariæ except rarely on the first

few adambulacral plates.  $R$  = slightly over 95 mm. (ray broken),  $r$  = 27 mm.,  $R$  = a little over 4  $r$ .

*Type*.—Cat. No. 30542, U.S.N.M.

*Type-locality*.—Station 5516, Mindanao Sea, off Point Tagolo, Mindanao, 175 fathoms, globigerina; bottom temperature, 54.3° F.

A large radial plate has 5 to 12 central, subspherical uncrowded granules and upward of 20 squarish, depressed, peripheral granules, a trifle smaller. On the lateral parts of the papular areas the central granules become more convex or elevated, with a short, incipient, mucronate tip; interradially the granules are flat-topped. The petaloid papular areas are broad, the extreme width comprising about 10 to 12 longitudinal series of plates. The first 2 or 3 adambulacral plates with 5 or 6 furrow spines, blunt, nearly equal, slightly compressed; then the plates gradually attain first a convex, then a strongly angular margin, and the furrow spines increase to 9 (less often 10), the 3 to 5 mesial nearest apex of angle being more slightly built, compressed, with edge to furrow, the 2 or 3 at either end of the series being stouter, sublanceolate, blunt, with flat side to furrow. Subambulacral granules 8 to 16, in 2 or 3 series on outer part of ray, but not so regularly arranged, as a rule, proximally. The outer granules are subconical or acorn-shaped, but a series of 2, 3, or even more back of the furrow spines are longer, slightly flattened, and rather tubercular in form.

*N. euryplax* closely resembles *N. belli* (Køehler), from 250 fathoms, off the Andaman Islands. It agrees in having the radial and adradial abactinal plates much broader than long, in having the ray broad at the base, with the fifth superomarginals conspicuously enlarged and in contact medially, and in the general absence of abactinal pedicellariæ, but differs in having the inferomarginals extending laterally beyond the superomarginals, so that the actinal surface is wider than the abactinal; in having longer, stouter rays; the 2 or 3 series of abactinal plates parallel to the adradial are not so wide in proportion to length—are nearly round, and have more numerous granules; the madreporic body is surrounded by 6 plates, not 4; the first row of suboral granules is enlarged into spines; the furrow spines are 9 or 10 at middle of ray (Køehler gives 7 or 8 for *belli*, but possibly he referred only to the proximal plates where in *N. euryplax* there are at first 5 or 6, then 7 or 8, and finally a maximum of 9 or 10).

**NYMPHASTER DYSCRITUS, new species.**

Differing from *N. euryplax* in having less obviously widened abactinal radial plates, slightly narrower superomarginals, the sixth being as long as or longer than wide (eighth to sixteenth in *euryplax*) when viewed directly from above; numerous abactinal pedicellariæ, a few superomarginal, inferomarginal, and actinal intermediate pedicel-

lariæ; narrower inferomarginal plates in the interbrachia; slightly coarser actinal intermediate granules. Rays at inner end of first pair of superomarginals which meet medially as wide as length of first  $3\frac{1}{2}$  superomarginals measured on ambitus; interbrachia arcuate; dorsal surface of ray nearly plane, with abrupt angles on the margin of disk and ray.  $R$  = probably nearly  $4r$ ;  $r$  = 23 mm.; breadth of ray at mid-interbrachium, 26 mm.

*Type*.—Cat. No. 30543, U.S.N.M.

*Type-locality*.—Station 5526, between Negros and Siquijor Islands, Philippine Islands, 279 fathoms, green mud; bottom temperature,  $52.3^{\circ}$  F.

This species resembles in general appearance *N. moluccanus*, and *N. ternalis* of Kœhler (but not Perrier) from the Indian region. Very likely the latter is a race of *dyscritus*. Kœhler's species has more regularly hexagonal abactinal plates, 8 adambulacral furrow spines (maximum?), more numerous adambulacral pedicellariæ (a variable character), 8 or 9 mouth spines, and the apophysis commences between the third or fourth and fifteenth adambulacral plates, varying on different specimens.

*N. dyscritus* has the apophysis appearing on the first plate, but not becoming conspicuous for 5 or 6 more plates. The first plate has 5 or 6 furrow spines which increase to 10, the laterals being broader than the 2 or 3 mesial spines, which are compressed to an even thickness, but are slightly tapering and round-tipped when seen from the side, as indeed are the laterals. Subambulacral granules 10 to 14, in about 3 series, the inner slightly longer than the outer. The first few plates have a pedicellaria with 2 or 3 coarse, tapering, slightly curved, bluntly pointed, spiniform jaws.

*N. dyscritus* differs from the true *N. ternalis* (Perrier) in having less tumid marginal plates, smaller abactinal radial plates, a sharper, more abrupt angle to margin of ray, longer superomarginals in proportion to their width (on ray) and in having the marginal apophysis on all the adambulacral plates.

#### NYMPHASTER MUCRONATUS, new species.

Very similar to *N. euryplax* in general form and in having the radial plates wider than long, but differing in having much less compact radial plates with fewer and mucronate granules; larger madreporic body; narrower inferomarginals; coarser, and more tuberculate, sometimes mucronate, unequal, actinal intermediate granules; smaller mouth plates, with the first adambulacrals nearly or quite meeting behind them; many of the subambulacral spines of conspicuous size, and graduated into the tubercular granules of the actinal intermediate plates. Rays broad at base, the width at inner end of the first 2 superomarginals which meet medially equaling first 4 superomarginals measured on ambitus; interbrachia arcu-

ate; inferomarginals defining contour of ray; dorsal surface of ray nearly plane; normal marginal plates not tumid, though inferomarginals with slightly arched ventral surface; adambulacral furrow spines 4 or 5 on first few plates, these gradually increasing to 9 or 10; oral spines 6 or 7.  $R = 101$  mm.,  $r = 30$  mm.,  $R = 3.4 r$ ; breadth of ray at mid-interbrachium, 34 mm.

*Type*.—Cat. No. 30544, U.S.N.M.

*Type-locality*.—Station 5116, mouth of Balayan Bay, Luzon (off Verde Island Passage, north coast of Mindoro), 200 fathoms; bottom temperature,  $50.2^{\circ}$  F.

*N. mucronatus* differs from *N. belli*, to which the form of the radial plates would ally it, in having mucronate granules, larger madreporic body surrounded by 6 plates, inferomarginals extending laterally beyond supermarginals, larger, unequal acorn-shaped, often incipiently mucronate, actinal intermediate granules, smaller mouth plates, and numerous, stout subambulacral spines.

NYMPHASTER LEPTODOMUS, new species.

In the form of the abactinal plates resembling *N. mucronatus*, but differing in having longer, slenderer rays, narrower supermarginals, inferomarginals extending little or not at all beyond supermarginals, subspherical, depressed, sometimes truncate abactinal granules, abactinal, spatulate pedicellariæ, larger mouth plates, 8 to 10 oral spines, adambulacral pedicellariæ, and no conspicuously enlarged subambulacral spines. Rays very slender, varying from plane to convex above, the width at inner end of the first pair of supermarginals which meet medially equal to length of first 3 supermarginals measured along side; adambulacral furrow spines proximally 6, distally 10 or 11.  $R = 70$  mm.,  $r = 17.5$  mm.,  $R = 4 r$ , breadth of ray at mid-interbrachium, 20 mm.

*Type*.—Cat. No. 30545, U.S.N.M.

*Type-locality*.—Station 5216, between Burias and Luzon, 215 fathoms, green mud; bottom temperature,  $51.9^{\circ}$  F.

NYMPHASTER MOLUCCANUS, new species.

Similar in general form to *N. euryplax*, but radial paxillæ smaller, hexagonal, and not conspicuously widened; petaloid papular areas narrower and oral spines 10 to 12; marginal plates rather broad; ray broad at base, the width at inner end of the first pair of supermarginals which meet medially equaling length of first  $4\frac{1}{2}$  supermarginals measured on ambitus; adambulacral plates with strong furrow angle; minimum number of furrow spines at base of ray 8 or 7; maximum number 10 (rarely 11).  $R = 86$  mm.,  $r = 21.5$  mm.; breadth of ray at mid-interbrachium, 26 mm.

*Type*.—Cat. No. 30546, U.S.N.M.

*Type-locality*.—Station 5622, between Gillolo and Makyan Islands, Molucca Islands, 275 fathoms, gray mud.

The petaloid papular areas are narrower than in *euryplax*, comprising 7 to 9 longitudinal series of plates. Proximal median radial plates with 8 to 10 circular, depressed, central granules (in 3 transverse series) and 15 or 16 slightly smaller, peripheral ones. Superomarginal plates broad, very faintly convex, and with an abrupt rounded angle at ambitus. They form a slightly raised border to disk, and one which is a trifle on a bevel; fifth superomarginals the largest, meeting medially. Superomarginal granules depressed, hemispherical, slightly larger than on neighboring abactinal plates, slightly spaced, with a regular beadlike marginal series. The apophysis or furrow angle of adambulacral plates begins on fourth or fifth plate and rapidly increases in prominence, the adoral facet of the apophysis being about two-thirds the length of the aboral, which is slightly hollowed out. The subambulacral granules are 15 to 25 in 3, sometimes 4, irregular rows; outer granules hemispherical, becoming somewhat four-sided or prismatic toward the furrow, and on the disk the innermost series is enlarged into short tubercular subprismatic spines, which decrease in length as the base of ray is approached. On the disk a few plates have a small pedicellaria, with 3 slender curved jaws, in the inner series of subambulacral spines, opposite the furrow angle.

This species differs from *N. ludwigi* (Kœhler) in having broader rays at the base, which taper more abruptly; more numerous marginals in each interbrachium; wider adambulacrals with 3 or 4 rows of granules instead of 2; a much more prominent apophysis proximally on the adambulacral plates; a few adambulacral and actinal intermediate but no marginal nor abactinal pedicellariæ; madreporic body surrounded by 5 or 6 plates instead of 4.

**NYMPHASTER ARTHROCNEMIS, new species.**

In the form of the marginal plates resembling *N. ternalis* (Perrier) but with smaller disk, longer rays, smaller radial abactinal plates, smaller papular areas; furrow angle of adambulacrals beginning with the third or fourth instead of the twenty-fourth plate; no adambulacral and marginal pedicellariæ. Marginal plates tumid, the median line of ray depressed below the lateral angle of superomarginals; ray rather slender from the base, the width at inner end of first pair of superomarginals which meet medially equaling length of first 4 superomarginals (or a trifle less); radial plates hexagonal; mouth plates with 9 marginal spines and adambulacrals with at first 7 furrow spines and at middle of ray 9 to 11, usually 10; actinal granulation coarse; no pedicellariæ except on abactinal plates. R = 85 +



mm.,  $r=21$  mm.,  $R$  = over  $4r$  (small portion of tip of ray broken); breadth of ray at mid-interbrachium, 24 mm.

*Type*.—Cat. No. 30547, U.S.N.M.

*Type-locality*.—Station 5648, Buton Strait, Celebes (lat.  $5^{\circ} 35' S.$ ; long.  $122^{\circ} 20' E.$ ), 559 fathoms; bottom temperature,  $39.2^{\circ} F.$

NYPHASTER MESERES, new species.

Similar in proportions and general form to *N. arthrocnemis* but marginal plates not tumid (although ray is sharply four-angled) and dorsal surface is subplane; sixth and sometimes fifth superomarginal longer than width of dorsal surface (tenth in *arthrocnemis*); third inferomarginal longer than width of its actinal surface; superomarginal and inferomarginal two-jawed slender pedicellariæ regularly present. Width of ray at proximal end of first pair of superomarginals which meet medially equaling first  $3\frac{1}{2}$  to  $3\frac{3}{4}$  superomarginals, measured along ambitus; radial abactinal plates hexagonal to roundish; oral spines 9 to 11; furrow spines increasing from 5 or 6 to 10, 11, and 12 far along ray.  $R$  = about 60 mm.,  $r=17$  mm.,  $R=3.6r \pm$ ; breadth of ray at mid-interbrachium, 19 mm.

*Type*.—Cat. No. 30548, U.S.N.M.

*Type-locality*.—Station 5115, off northern Mindoro (Verde Island Passage), 340 fathoms.

This species is most likely to be confused with *N. arthrocnemis* and *N. habrotatus*. It differs from the latter in having square-angled rays, with a plane dorsal surface, a closer marginal granulation, the sixth and sometimes the fifth superomarginal longer than width of its dorsal surface (ninth or tenth in *habrotatus*); 10 inferomarginals corresponding to about 16 adambulacrals (13 or 14 in *habrotatus*); coarser actinal interradial granulation; fewer mouth spines (12 to 15 in *habrotatus*); primary apical plates smaller—not conspicuous, whereas they are in *habrotatus*.

NYPHASTER HABROTATUS, new species.

Rays long and slender as in *N. arthrocnemis*, but not tumid, the dorsal surface of ray evenly arched proximally, and oral spines 12 to 15; contour of ray as seen from below, even, not constricted at intervals; breadth of ray at inner end of the first pair of superomarginals which meet medially equal to first 3 to  $3\frac{1}{2}$  superomarginals measured on ambitus; superomarginals, as seen from above wider than long up to the sixth or seventh; the next 2 or 3 squarish; granules round and well spaced; a few marginal two-jawed pedicellariæ; median radial plates slightly wider than long, all slightly elevated; primary apical plates conspicuous; adambulacral plates with proximally 7 or 8 and farther along ray upward of 14 furrow spines; apophysis beginning on second or third plate, but becoming prominent gradually; adambulacral two- to four-jawed pedicel-

iaræ; third inferomarginal longer than wide as seen from below.  $R=76.5$  mm.,  $r=17$  mm.,  $R=4.5$  r; breadth of ray at mid-interbrachium, 19 mm.

*Type*.—Cat. No. 30549, U.S.N.M.

*Type-locality*.—Station 5491, between Leyte and Mindanao, 736 fathoms, green mud, coral; bottom temperature,  $52.3^{\circ}$  F.

NYMPHASTER ATOPUS, new species.

Differing from other species herein described in having only 4 interbrachial superomarginals; rays slender, the width at outer end of second superomarginals (which corresponds in position to the inner end of the first pair of plates which meet medially, in other species) equaling length of first 3 superomarginals measured on ambitus; superomarginals longer than wide; inferomarginals on ray very slender, resembling terete rods placed end to end; marginal granulation relatively coarse, spaced; abactinal plates small, roundish hexagonal, with few granules; oral spines 9 or 10; adambulacral furrow spines proximally 7 or 8, then 10 or 11; apophysis is prominent from the third plate on; distal plates much longer than wide, with 1 series of granules and a few extra in the angle of the apophysis; about 15 or 16 adambulacrals corresponding to 10 inferomarginals of ray. Cotype,  $R=43+$  mm.,  $r=9$  mm.,  $R=\text{at least } 5$  r (tip of ray broken).

*Type*.—Cat. No. 30550, U.S.N.M.

*Type-locality*.—Station 5428, Sulu Sea, off Palawan (lat.  $9^{\circ} 13' N.$ ; long.  $118^{\circ} 51' 15'' E.$ ), 1,105 fathoms, gray mud; bottom temperature,  $49.7^{\circ}$  F.

CERAMASTER SMITHI, new species.

In general appearance closely resembling *C. clarki* Fisher but differing in having less elevated abactinal plates, with shorter and differently formed basal lobes; more numerous granules, especially on center of tabulum; smaller pedicellariæ; coarser and characteristically formed subambulacral spines. General form arcuately pentagonal, produced at the corners into short blunt rays; body thin; margins thin, the plates being small as in *C. clarki*; abactinal plates very short lobed and with hexagonal crowns on papular areas, composed of 10 to 18 central and 15 to 22 peripheral, subequal, slightly spaced granules, and often a small, spatulate, 2-jawed pedicellaria; superomarginals longer than wide and with slightly spaced, flat, granules, except the last few plates which are wider than long and have a bare area; adambulacral plates with 4 or 5 coarse furrow spines and 3 coarser truncate subambulacral spines, the tips truncate and curiously etched out, pitted, and wrinkled, the grooving extending down the outer side; oral spines, 8 or 9.  $R=60$  mm.,  $r=31$  mm.,  $R=\text{nearly } 2$  r.

*Type*.—Cat. No. 30551, U.S.N.M.

*Type-locality*.—Station 5201, Sogod Bay, southern Leyte Island, 554 fathoms, gray sand, mud; bottom temperature, 52.8°.

This species is named in honor of Dr. Hugh M. Smith, Deputy Commissioner of Fisheries, in charge of the Philippine explorations.

PELTASTER CYCLOPLAX, new species.

Differing from *P. nidarosiensis* (Storm) in having entrenched, 2-jawed pincer-shaped or "sugar-tongs" pedicellariæ instead of the sessile, bivalved type; in having very many more granules on the abactinal plates, more tumid and longer proximal superomarginal plates, and very numerous actinal intermediate pedicellariæ; rays longer. General form stellate, with short rays and shallow, arcuate, interbrachia;  $R = 109$  mm.,  $r = 51$  mm.,  $R = 2.1 r$ ; breadth of ray at mid-interbrachium, 60 mm. Abactinal plates finely granulated, the larger primary plates with 35 or 40 peripheral, and 120 central, slightly smaller granules; proximal radial plates surrounded, partially or wholly, by smaller, secondary, plates; very numerous small abactinal, broadly spoon-shaped, denticulate pedicellariæ; superomarginals proximally very tumid, 15 or 16 to the ray, closely granulate except for a central irregular, bare space on many plates; a few superomarginal and inferomarginal pedicellariæ; actinal intermediate areas very large, closely granulate, nearly all the plates with 1 or sometimes 2 forceps pedicellariæ, so that in the aggregate they appear very numerous, the plates being small; adambulacral plates with 5 or 6 stout, blunt, 4-sided or compressed furrow spines, and 2 arcuate series of subambulacral spines (4 or 5 in each series) followed by 12 to 15 granules, in 2 crowded, irregular series.

*Type*.—Cat. No. 30552, U.S.N.M.

*Type-locality*.—Station 5279, China Sea, near Malavatuan Island, Southern Luzon. 117 fathoms on a bottom of green mud.

The pedicellariæ of *P. nidarosiensis* are of the bivalve type characteristic of *Hippasteria*, whereas in *cycloplax* they are of the entrenched 2-jawed sugar-tongs type, similar to those of *Nymphaster*, and other related genera. If *P. hebes* Verrill is distinct from *nidarosiensis*, it will differ in practically the same characters as that species. *P. planus* Verrill lacks pedicellariæ entirely, and has fewer abactinal granules to the plate, wider and less tumid superomarginal plates, and only 3 or 4 furrow spines.

SPHÆRIODISCUS SCOTOCRYPTUS, new species.

In general appearance greatly resembling *Ceramaster granularis* (except as regards the enlarged antepenultimate superomarginals). Differing from *S. ammophilus* (Fisher) and *S. bourgeti* (Perrier) in having much narrower superomarginals, more restricted papular areas, much longer adambulacral plates with more numerous furrow spines,

and larger mouth plates. Form pentagonal, with straight sides, produced at the angles into rays only 2 superomarginals in length. Superomarginals narrow, increasing slightly in size up to the third, the remaining 2 being smaller; surface bare, except for scattered granules, and several rows near margin. Abactinal plates granulate, a comparatively few of the radial and adradial series being low tabulate; plates hexagonal on radial regions, generally 4-sided interradially, and irregularly hexagonal on center of disk. Adambulacral plates longer than wide, or as long as wide, with a straight-edged furrow comb of 9 or 10 flattened, rather narrow, truncate spines, and spaced from these 2 or 3 subambulacral series of granules, the inner the larger. Mouth plates large with 15 to 17 furrow spines. Abactinal, marginal, and actinal intermediate spatulate pedicellariæ with "sugar-tongs" jaws.  $R=32$  mm.,  $r=22$  mm.,  $R=1.45$  r.

*Type*.—Cat. No. 30553, U.S.N.M.

*Type-locality*.—Station 5425, Sulu Sea near Cagayanes Island, 495 fathoms, gray mud, coral sand.

ICONASTER PERIERCTUS, new species.

Differing from *I. longimanus* in having more elevated, and rough superomarginals; all the abactinal plates perfectly smooth and with a complete series of peripheral granules; a less compact adambulacral armature with fewer spines and granules.  $R=23$  mm.,  $r=10$  mm.,  $R=2.3$  r; breadth of ray at inner end of third superomarginals, 6 mm., or the length of the first 3 superomarginals measured on ambitus. Superomarginals tabulate, separated by conspicuous grooves, the surface having irregular elevations but no granules nor blister-like minute bosses; beyond the second plate they are united on the median line of ray; abactinal area sunken, the plates perfectly smooth with a single peripheral series of granules largest on the radial papular areas; peripheral plates tumid, the others slightly swollen, with a plane surface, but not tabulate; plates of center of disk very conspicuously the largest; inferomarginal plates tumid, the first 3 or 4 perfectly smooth, the remainder with slight roughening; actinal intermediate plates in 3 chevrons, smooth, with a single peripheral series of oblong granules; adambulacral plates small, wider than long with 3 or 4 small, stubby, furrow spinelets and following these, 2 shorter, compressed, flat-sided granules, the outer part of the plate being occupied by 4 or 5 small prismatic granules.

*Type*.—Cat. No. 30554, U.S.N.M.

*Type-locality*.—Station 5166, 4.6 miles southeast of Observation Island, Tawi Tawi Group, Sulu Archipelago, 97 fathoms, coral sand; bottom temperature,  $69.4^{\circ}$  F.

The generic position of this species is puzzling. The dorsal skeleton and the very tumid, roughened, superomarginals would ally it to

*Astroceramus*. But the actinal intermediate plates are like those of *Iconaster* and *Lithosoma*, being without central granules. The adambulacral armature is similar to that of *Iconaster* while suggesting *Astroceramus* in the slightly more differentiated inner subambulacral series and in the presence of a conspicuous transversely oriented pedicellaria. To put these facts in a different way: *I. perierctus* differs from *Iconaster* in having the dorsal radial plates entirely surrounded by granules, and in having the tumid superomarginals roughened by uneven elevations (which, unlike those of *Astroceramus*, do not have scattered granules). It differs from *Astroceramus* in lacking any trace of marginal and enlarged central actinal intermediate granules, in having the adambulacral armature graded from the short furrow spines to the outer granules, and in the absence of a conspicuously enlarged subambulacral on the outer part of the ray.

ASTROCERAMUS LIONOTUS, new species.

Similar in appearance to *A. callimorphus* but differing in having less tumid marginal plates, especially on the ray, slightly smaller abactinal plates, and very strongly compressed, bladelike, subtruncate furrow spines; subambulacral pedicellariæ slenderer and longer than the actinal intermediate pedicellariæ, not similar to them.  $R = 79$  mm.,  $r = 22$  mm.,  $R = 3.6 r$ ; breadth of ray at inner end of first pair of superomarginals which meet medially equal to length of first  $3\frac{2}{3}$  or 4 superomarginals measured on ambitus; thickness of disk interradially equal to length of  $1\frac{1}{2}$  adjacent superomarginals. Abactinal plates flat, smooth, except for minute hyaline bosses, and bordered by small granules flush with the general surface; superomarginal plates massive, increasing in size up to the third or fourth, which meet medially; margin of ray forming an abrupt right angle, with uneven elevations bearing scattered deciduous granules, these encroaching upon surface of plates interradially; a few marginal sugar-tongs pedicellariæ; inferomarginals slightly and unevenly tumid, with upward of 30 deciduous granules; marginals bordered by a moniliform series of small granules; actinal interradiial areas very similar to those of *A. callimorphus*; furrow spines 4 or 5, compressed, and widened at tip; subambulacral spines 2 or 3, heavy, with proximally, between them a slender spatulate two-jawed pedicellaria; on outer part of ray, subambulacral spine single and much longer than furrow spines.

*Type*.—Cat. No. 30555, U.S.N.M.

*Type-locality*.—Station 5523, 6.7 miles northeast of Point Tagolo, northern Mindanao; depth and bottom not recorded.

## ASTROCERAMUS SPHÆRIOSTICTUS, new species.

Similar in general appearance to *A. lionotus* but differing in having 1 or 2, rarely upward of 5, acorn-shaped, tubercular granules on the middle of the abactinal plates; numerous abaectinal, broadly spatulate, or narrowly fan-shaped sugar-tongs pedicellariæ; more numerous marginal granules, scattered over the entire surface of marginal plates; larger and more numerous actinal intermediate pedicellariæ and coarser tubercular granules; more numerous subambulacral pedicellariæ; proximally slenderer furrow spines; commonly only 1 larger subambulacral spine, or if 2, these frequently in a transverse series; slenderer oral spines.  $R = 73$  mm.,  $r = 22.5$  mm.,  $R = 3.2 + r$ ; breadth of ray at proximal end of third pair of superomarginals (which meet medially) equal to length of first  $4\frac{1}{2}$  superomarginals measured on ambitus. Abactinal plates subcircular with a single marginal moniliform series of tiny granules and 1 to several much larger tubercular acorn-shaped granules in center; marginal plates tumid, with uneven elevations bearing numerous deciduous granules in lines and groups; actinal intermediate plates with 3 to 6 prominent acorn-shaped tubercular granules on the surface and a single moniliform series of subconical or subfoliaceous granules on the margin; pedicellariæ numerous, with 2 rather large, narrowly fan-shaped or abruptly spatulate jaws; furrow spines 4 or 5, slender, and only a trifle compressed proximally, distally markedly compressed; subambulacral spines heavy, clavate, proximally larger than in *A. lionotus*, and sometimes furrowed near the tip; subambulacral pedicellariæ numerous, 1 to a plate, the jaws slender, spatulate, and nearly or quite as long as the furrow spines.

*Type*.—Cat. No. 30556, U.S.N.M.

*Type-locality*.—Station 5135, 11.9 miles northeast of Jolo Light, Jolo, Sulu Archipelago, 161 fathoms, fine coral sand; bottom temperature,  $54.7^{\circ}$  F.

## CALLIASTER CORYNETES, new species.

Differing from *C. childreni* in having much heavier marginal and actinal spines, and numerous pedicellariæ; from *C. pedicellaris* in having heavy actinal intermediate spines, more numerous and longer furrow spines, and prominent spines in the center of disk; from *C. baccatus* in having longer spines generally, numerous pedicellariæ, more numerous furrow spines, and a few prominent abactinal spines instead of tubercles all over the abactinal area.  $R = 40$  mm.,  $r = 15$  mm.,  $R = 2.66 r$ ; breadth of ray at base, 18 mm. Disk large, rays rather slender and blunt, the interbrachia being wide and rounded. Marginals very massive, wider on outer part of ray than the abactinal area, very tumid, each bearing a very robust, rigid blunt spine (2 on first plate), the general surface of the plates being smooth; ter-

minal plate large, with 5 heavy spines; inferomarginals with 2 stout spines and a few pedicellariæ; abactinal plates smooth, bordered by a single series of flat, flush granules, the 5 primary radials and 1 or 2 other radials, as well as the central plate, with a heavy upright blunt spine, the remaining median radial plates and most of the larger plates of central part of disk with a central tubercular granule; numerous very broadly spatulate, foliaceous pedicellariæ; actinal intermediate plates each with a heavy blunt spine (sometimes 2) and a broadly spatulate intrenched pedicellaria; adambulacral plates with a palmate furrow series of 5 to 7 unequal, rather slender, more or less compressed spines, and distally 1, proximally 2, heavy subambulacral spines, resembling those of actinal intermediate plates.

*Type*.—Cat. No. 30557, U.S.N.M.

*Type-locality*.—Station 5280, between Lubang and Luzon, south of Manila Bay, 193 fathoms, gray sand; bottom temperature, 49.6° F.

#### ASTROTHAUMA, new genus.

Differing from *Calliaster* Gray in having the last superomarginal plate much enlarged and in having the marginal and actinal spines with a roughened or thorny surface; plates smooth, bordered by a single series of granules, and with small two-jawed upright pedicellariæ; marginal and actinal plates with heavy, thorny, or roughened spines; prominent upright smooth or slightly eroded spines on center of disk and basal portion of ray; furrow spines numerous, small, in a close comb; subambulacral spines 2 or 3, large, rough, tapering, and sharp.

*Type of the genus*.—*Astrothauma euphylacteum*, new species.

#### ASTROTHAUMA EUPHYLACTEUM, new species.

Rays 5.  $R=86$  mm.,  $r=24$  mm.,  $R=3.5+r$ ; breadth of ray at base, 27 mm.; thickness of disk at interradius, 8.5 mm. Disk fairly large; rays gradually tapering, rigid, blunt; abactinal plates smooth, bordered by a single series of granules; center of disk and proximal third of radial series with prominent, stout, sharp, upright spines and a few scattered small two-jawed pedicellariæ; superomarginals with the distal-most plate much enlarged and each with 2 or 3, abnormally as many as 5, prominent, sharp spines; inferomarginals with proximally 6 to 8 unequal, tapering, sharp, roughened, or thorny spines, becoming reduced to 4 at middle of series, then 3, and finally to 1 or 2 at end; actinal intermediate plates usually with a sharp thorny spine, at the base of which is a small blunt spatulate pedicellaria with 2 swollen jaws; adambulacral plates with 12 to 17 small compressed furrow spines in a close comb, and 2 or 3 sharp, heavy, roughened, subambulacral spines in an oblique series.

*Type*.—Cat. No. 30558, U.S.N.M.

*Type-locality*.—Station 5412, between Cebu and Bohol, 162 fathoms, green mud; bottom temperature, 54.8° F.

This genus is essentially *Calliaster* with swollen or enlarged terminal superomarginal plates and thorny or roughened spines. The last character suggests *Milteliphaster* Alcock which has the actinal spines ending in swollen bifid or multifid points. The character of the actinal spines is apparently the only one which separates *Milteliphaster* from *Calliaster*.

#### Genus ANTHENOIDES Perrier.

*Anthenoides* PERRIER, Bull. Mus. Comp. Zoöl., vol. 9, 1881, p. 23.—Type, *A. peircei* Perrier.

*Leptogonaster* SLADEN, Challenger Asteroidea, 1889, p. 326.—Type, *A. cristatus* Sladen.

*Antheniaster* VERRILL, Trans. Conn. Acad., vol. 10, 1899, p. 173.—Type, *Anthenoides sarissa* Alcock.

A comparison of specimens of *Leptogonaster cristatus*, of which there are numerous examples in the Philippine collection, with *Anthenoides peircei* reveals no differential characters of generic importance. *Anthenoides sarissa*, the type of *Antheniaster*, is very closely related to and very evidently congeneric with *Leptogonaster cristatus*. *Leptogonaster* and *Antheniaster* should therefore be abandoned.

The three species herein described belong to a section of the genus, of which *A. epixanthus* is typical, in which the inferomarginals are without lateral spines. These are present in the adults of *peircei*, *cristatus*, and *sarissa*.

#### KEY TO THE SPECIES OF ANTHENOIDES LACKING LATERAL SPINES.

- a<sup>1</sup>. Pedicellariæ only on the adambulacral plates; abactinal granules few and microscopic, visible only when abactinal membrane is dried; the abactinal area has superficially the appearance of being without granules.....*epixanthus*.
- a<sup>2</sup>. Pedicellariæ on the abactinal and actinal intermediate areas, as well as on the adambulacral plates; abactinal granules numerous, at least in center of disk, and easily seen without magnification.
- b<sup>1</sup>. Superomarginals decreasing regularly and gradually in length from the first; granules distributed uniformly all over abactinal area.
- c<sup>1</sup>. R=2 r; central granules of each abactinal plate the largest; proximal superomarginal plates coarsely granulated all over; superomarginals all wider than long.....*granulosus*.
- c<sup>2</sup>. R=2.6 r; granules smaller, uniform; superomarginals finely granulated, only a few proximals with coarse central granules; superomarginals at middle of ray longer than wide.....*rugulosus*.
- b<sup>2</sup>. Superomarginals maintaining their width to near end of ray; granules numerous in center of disk, becoming much smaller and more widely spaced as periphery is approached; superomarginals of proximal half of ray with coarse central granules.....*lithosorus*.



## ANTHENOIDES GRANULOSUS, new species.

Similar in general appearance to *A. epixanthus* (Fisher) but differing in having much more numerous and coarser abactinal and marginal granules; numerous small abactinal and actinal intermediate, bivalved pedicellariæ; more numerous adambulacral pedicellariæ, which are relatively larger; slender, and slightly more numerous furrow spines, and more numerous oral spines.  $R=79$  mm.,  $r=39$  mm.,  $R=2r$ ; breadth of ray at interbrachium, 43 mm.; disk very large with open, arcuate interbrachia and short, tapering, bluntly pointed rays; whole surface overlaid by soft membrane, obscuring the underlying plates, especially the abactinals, which are covered with spaced granules larger than in *epixanthus*; marginal plates covered all over with spaced granules, coarsest on outer part of plate, and more numerous than in *A. epixanthus*; no marginal spines; actinal intermediate granules coarse and numerous; furrow spines slender, compressed, 6 to 9, the adoral end of the plate with a large, slender, forcipiform pedicellaria, and 1 to 3 more on the actinal surface; subambulacral spines, 1 to 4, according to the number of pedicellariæ, which they partly replace; oral spines 13 to 15, with several suboral pedicellariæ and numerous suboral granules.

*Type*.—Cat. No. 30559, U.S.N.M.

*Type-locality*.—Station 5626, between Gillolo and Kayoa Islands, Molucca Islands, 265 fathoms, gray mud, fine sand.

## ANTHENOIDES LITHOSORUS, new species.

Closely related to *A. granulatus*, but differing in having the coarse superomarginal granules confined to the center of plate, surrounded by a conspicuous area with only spaced microscopic grains; abactinal granules fine, subequal, thick on center of disk, becoming smaller and more spaced as the margin is approached, fewer than in *granulosus*, smaller, and the central granules of the plate not larger than the others; superomarginal plates more tumid, the width remaining the same to within 4 or 5 plates of end of ray (regularly decreasing in length in *granulosus*); furrow spines 9 or 10; oral spines 15 or 16.  $R=80$  mm.,  $r=44$  mm.,  $R$ =about 1.8  $r$ . General form similar to that of *granulosus* but the rays are thicker toward the end owing to the heavier superomarginals, the last 6 or 7 pairs of which are in contact medially.

*Type*.—Cat. No. 30560, U.S.N.M.

*Type-locality*.—Station 5301, China Sea, vicinity of Hongkong (lat.  $20^{\circ} 37' N.$ ; long.  $115^{\circ} 43' E.$ ), 208 fathoms, gray mud, sand; bottom temperature,  $50.5^{\circ} F.$

The abactinal area is overlaid by a thick membrane which in drying allows the small granules to be seen. These are subequal and about the size of the smallest granules of *granulosus*. Only in the

center of disk are they as numerous as in *granulosus*, and as just indicated they are not larger in the center of the plate (which is a characteristic of *granulosus*.) Superomarginals 18. The first 7 plates have a central group of coarse, hemispherical granules, which in a dried specimen remind one of little heaps of stones. The first plate has 24 granules and the seventh, 5 or 6. The first inferomarginals are covered with coarse granules which decrease in size from the edge of ray toward the inner margin of plate.

ANTHENOIDES RUGULOSUS, new species.

Differing from *A. granulosus* in having longer, slenderer rays, narrower marginal plates, rather more numerous and smaller *uniform* abactinal granules, a fine superomarginal granulation (except for a few central coarse hemispherical granules on the proximal plates) and more elevated, pincer-shaped abactinal pedicellariæ.  $R=124$  mm.,  $r=47$  mm.,  $R=2.6+r$ ; breadth of ray at first superomarginal, 52 mm. Disk large, rays distally narrow, tapering arcuately from wide interbrachia; disk more or less inflated; whole body overlaid by smooth, rather thick, soft skin, minutely wrinkled on the abactinal area and covering a fine, close, uniform granulation; small forceps-shaped, abactinal pedicellariæ; superomarginal plates smooth, the membrane covering fine, spaced granules, and on the proximal plates a few scattered coarse central granules; superomarginals of middle region of ray in large specimens longer than wide; actinal interradial areas variable, usually fairly smooth, the plates with central, enlarged, hemispherical granules, as in *granulosus*; the plates adjacent to adambulacrals with a variable number of forcipiform or spatulate, lower, pedicellariæ; furrow spines compressed, usually 7 or 8 proximally, varying to 6 to 9, the armature in general similar to that of *A. granulosus*; oral spines, 14 or 15.

*Type*.—Cat. No. 30561, U.S.N.M.

*Type-locality*.—Station 5121, 9 miles southeast of Malabrigo Light, east coast of Mindoro, 108 fathoms, green mud.